# MARINE ENGINEERING.

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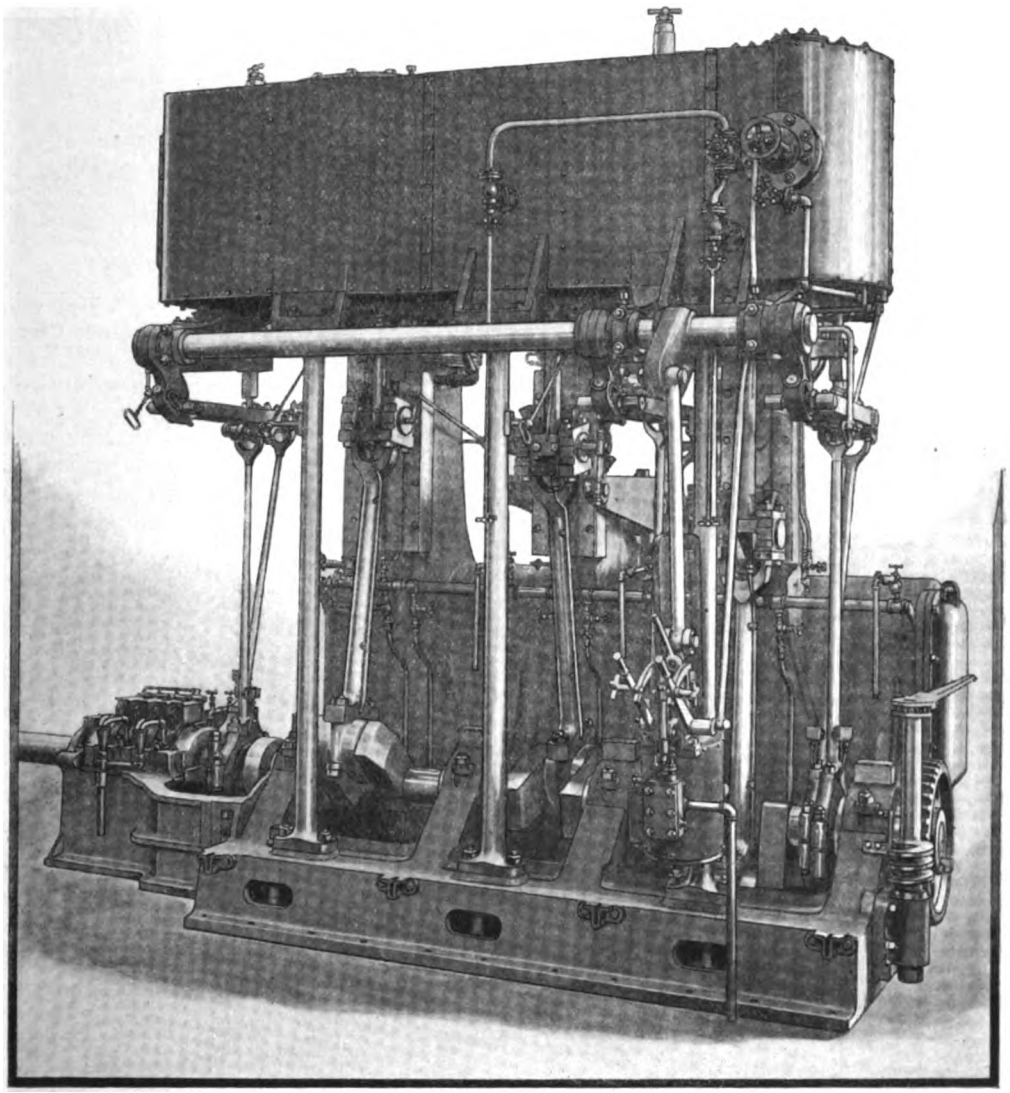
## NEWEST AMERICAN BUILT STEAMSHIP FOR HAWAIIAN ISLANDS TRADE.

Recent contracts secured by the Union Iron Works, of San Francisco, Cal., have not been for war vessels alone. The growth of the trans-Pacific trade has created a demand for tonnage which has necessitated the building of numerous ocean-going vessels on the Pacific coast, and has, as a matter of course, stimulated ship building in that section of the country.

The Wilder Steamship Company, of Honolulu, when contemplating the enlargement of its inter-island fleet gave much attention to vessels turned out of British shipyards. It was argued that there was much to be saved in the matter of cost



TRIPLE EXPANSION ENGINE OF THE HAWAIIAN ISLANDS STEAMSHIP HELENE.

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by awarding contracts to the shipyards of the United Kingdom. But after careful consideration it was decided to file specifications for two steel steamers of about 450 tons with the Union Iron Works. As a result of the placing of these orders the swift, strong and comfortably-appointed steamer Helene is now engaged in the Island trade, and upon the ways at the Union Iron Works' yard is the frame of a sister ship.

The Helene was built to conform to the rules of the Bureau Veritas. She is schooner rigged, with pole masts made extra heavy to bear the strain they will be subjected to in handling the machinery cargoes required on the sugar plantations of the Hawaiian group. Her length at the water line is 175 ft., beam 30 ft., and depth of hold 15 ft. The hull is divided by five water-tight bulkheads.

The Helene's accommodations on the main deck are as elaborate in design and finish as those of larger and more extensively-advertised liners. There is a steel midship house containing a handsome dining saloon—finished in hardwoods—pantry, galley, engine and boiler rooms, officers' quarters, cooks', waiters' and firemen's apartments, and six passenger staterooms, complete in every detail.

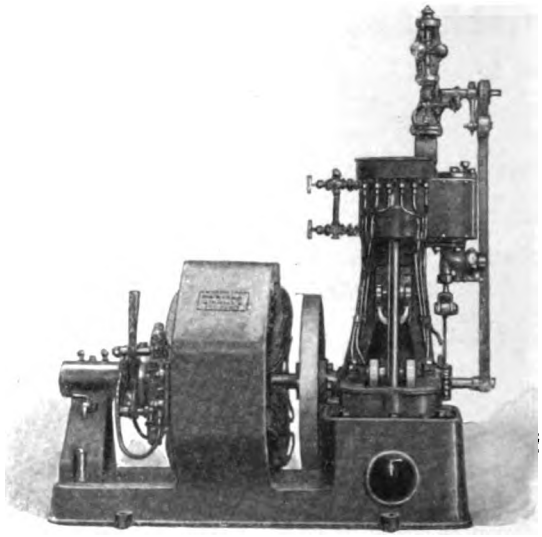
On the upper deck of the midship house is the pilot house, captain's room, two passenger rooms and quarters known as "the President's room," an elegantly-fitted apartment intended for the accommodation of President Dole, or the President of the Wilder Steamship Company, or the corporation's officials, when they travel from island to island of the Hawaiian Republic. Surrounding all these apartments is a shade deck.

On the forecastle deck is a steam windlass. The forecastle is fitted with 18 berths, a large crew being required in the Hawaiian inter-island trade to handle freight in the open roadsteads in ship's boats built especially for the service. On both the forward and after decks there is a double cylinder cargo winch, each capable of handling 4,000 pounds in a whip, and fitted with friction-disengaging gear as well as link-reversing motion. The handling of cargoes from and into boats in the large ocean swells of the island waters necessitates that special provision be made in many details to prevent loss or breakage of packages.

Arrangements are made on deck for carrying cattle and miscellaneous and bulky articles which cannot be stowed in the hold conveniently. Cattle bars and boards are fitted for about 60 head of cattle.

The main engine is of the triple-expansion type, with cylinders 12 3-4 in., 19 in., and 32 in. by 24 in. stroke. The valves are worked by the ordinary Stephenson link motion, fitted with steam reversing gear. Watson's patent metallic packing is used on all rods and valve stems. All bearings are lined with Union white bronze. The air, bilge, and feed pump is worked by levers from the crosshead of I. P. engine. The circulating water is supplied by an independent centrifugal pump, which is fitted with a bilge connection.

The thrust bearing is of the horse-shoe type,



UNION IRON WORKS GENERATING SET.

lined with Parson's white bronze, and with water circulating through the horse-shoe rings.

The propeller is right-handed, four-bladed, of manganese bronze, 8 ft. 3 in. dia. and 9 ft. 6 in. pitch.

The main boiler is 12 ft. dia. by 11 ft. 3 in. long, and has two Morison suspension furnaces each 44 in. outside dia. The boiler contains 1,580 sq. ft. heating surface, and the spring-loaded safety valves are adjusted for a working pressure of 165 lbs. per sq. in.

The feed water passes through a live steam coil heater and enters the boiler at a temperature of 212 deg. Additional provision is made for feeding with an injector when in way ports, as well as with the auxiliary steam feed pump.

A donkey boiler is fitted in the upper part of the fire room, having the same steam pressure as the main boilers and connected to winches, windlass, steam pumps, and dynamo engine.

The electric light is supplied by a direct-driven dynamo of 5 K. W., Union Iron Works pattern, making 500 revolutions per minute. It is located close to the starting platform.

The vessel carries 670 tons of sugar in the holds, and averages on her regular service a speed of 10 knots, developing 420 indicated horse power. She has proved to be a very successful investment.

The Union Iron Works is at present busy on a number of new vessels, which include the Fannie Irwin, a sister ship to the Helene, the Japanese cruiser Chitose, the U. S. battleship Wisconsin, and the torpedo boat destroyer Farragut. The company has also orders booked for two coasting steamers and for a large ferryboat.

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WILDER STEAMSHIP CO.'S PASSENGER AND CARGO STEAMSHIP HELENE, ENGAGED IN HAWAIIAN ISLANDS TRADE.

*(Built and Engined by Union Iron Works, San Francisco, Cal.)*

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## EXPERIMENTAL TANK AS AN AID TO MARINE ENGINEER AND NAVAL ARCHITECT.

BY PROF. W. F. DURAND.

In all branches of engineering work problems are continually arising, the solution of which cannot be found without the aid of experimental investigation. No more ample illustration of this truth can be found than in the field concerned with the design and construction of ships and their propelling machinery. Of the many problems which may thus arise, however, we are, in the present article, concerned only with such as depend on the forces developed by the motion of a solid body through or in a liquid. The problems thus brought before us are those relating to resistance and propulsion as affecting the general problem of marine design and construction.

Now, it is a fact that, notwithstanding the enormous advances made by the science of mathematics, it is still entirely unable to deal, in the general case, with the phenomena attending the motion of a body through a liquid. The forces involved in such case depend on so many variable conditions of the problem and are related to these conditions in such obscure ways that hitherto all attempts at a mathematical discussion of the problem have been futile. Our only recourse in such case is therefore to determine by experimental investigation, such features of the solution as are needed for the purpose in hand.

Such experimental investigation may be either direct or indirect. In the first case the objects involved in the problem are made or represented full size, the conditions of the problem are produced, and the forces involved are measured directly. Thus, for example, the resistance of a torpedo boat might be determined experimentally by building the boat and towing it at a series of speeds and measuring by a traction dynamometer the forces involved. Or, again, the performance of a screw propeller might be investigated by making the propeller full size, producing the conditions of use, and determining the data desired. Where possible, such direct methods are naturally the best, but it is rare that experimental work can be carried on in this way, and, even if it could, the value of the data taken would be comparatively small were its application limited to the case for which it was directly observed. In fact, the broad and fundamentally important principle of experimental work of the kind we are now considering lies in the possibility of applying the data for any one case to an indefinite number of others through accepted laws of relationship and comparison between them. Such laws being accepted as a working basis, it becomes possible to represent the object under investigation by a comparatively small model. The latter is then made the subject of direct examination under a set of conditions connected with the fundamental conditions according to the laws of relationship mentioned above. The data thus found is then used according to these laws, and the desired final results determined. But this is not all. The data having thus served its immediate purpose may than be filed away for future use, and may be made to serve as occasion arises, for an indefinite series of other problems under properly related conditions. We shall not here enter into these laws of relation and comparison. It will be sufficient to note simply that their object is to render as far as possible the investigation independent of size or dimension, so that the series of cases referred to above may consist of an indefinite series of sizes, all of the same form and proportion, and operated under speeds related to that of the original model according to the law of relationship used.

With this general introduction we will now take a nearer view of the application of these principles to the experimental investigation of the resistance of ships and the performance of screw propellers, these being practically the most important parts of the general field of work here brought to our notice.

The ship is represented by a model usually in paraffine, and to such scale as to bring its length from ten to fifteen feet. A block of paraffine is first cast roughly to shape. This block is then placed on the bed of the model forming machine, shown in plan in Fig. 1[1]. The block here passes to and fro under rapidly revolving cutters which are moved by a pantographic connection with a tracing point or disk, the latter being carried by the operator tangent to the water lines of the vessel whose form is to be reproduced. In this way successive water lines are cut out at the proper successive heights on the surface of the future model, the cross sections at the end of this stage resembling series of steps whose inner corners are on the surface desired. The outer corners are then worked off smoothly by hand tools until the inner angle of the path cut by the tool barely remains. The surface is then smoothed and polished and is ready for the trials. The canal or tank in which the trials are made should have a length of from 350 to 500 ft. by 20 or 25 ft. width and 10 or 12 ft depth.

Spanning the tank, as shown in Fig. 2,[2] is a truck or carriage running on rails laid on either side. This truck is connected with a steam engine or other motor through a wire rope or other cable, and winding drum, and by this means a given speed once obtained may be maintained sensibly uniform throughout the remainder of the run. The engines used in the establishments installed in Europe are controlled by a specially sensitive governor designed by the late William Froude, by means of which the slightest variation in speed is met and counteracted, and a very high degree of uniformity is obtained. The truck is also provided with means for holding the model in such way that it shall be free to take whatever trim the conditions of the experiment may tend to give it. The cradle holding the

[1]Reproduced from the paper by R. E. Froude, published in Transactions of Mechanical Engineers, London, 1893.

[2]Reproduced from the paper by R. E. Froude as above.

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model is also connected with a traction dynamometer so that the resistance opposed to the motion is transmitted through the cradle to the dynamometer and there automatically recorded on a drum given motion by connection with the truck. This provides for the determination and record of the revolutions of which are counted and electrically recorded also on the revolving drum.

These various items furnish the necessary data from which the resistance of the model at a given speed may be determined. Such models are usually tried at a large number of speeds and at

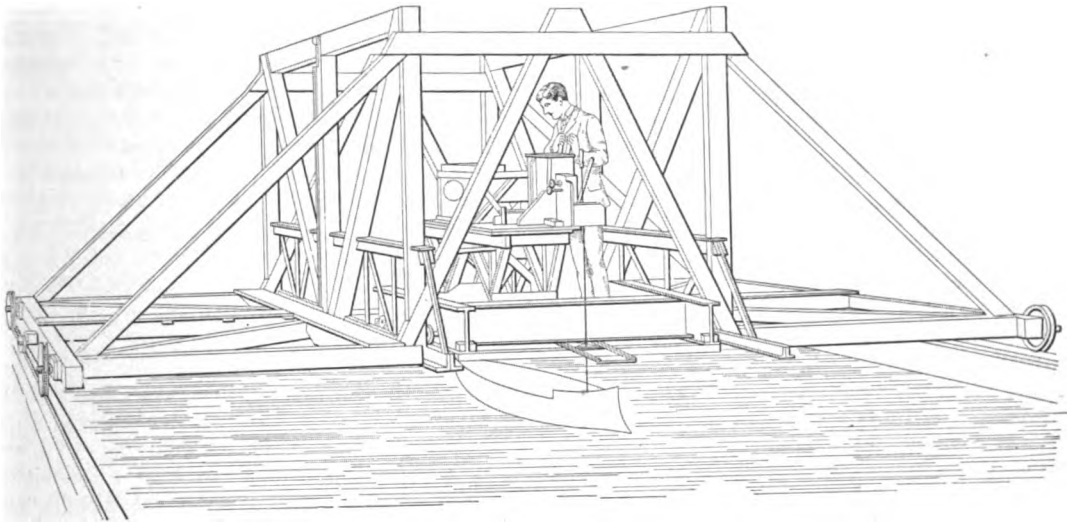

FIG. 2.—CARRIAGE CARRYING CRADLE FOR HOLDING MODEL.

the resistance. The remaining item, the speed, is determined by electrically recording signals sent by a clock with a make or break in the circuit every second, and also marks denoting equal distances measured along the track, as, for example, three or more immersions varied by adding or subtracting ballast, and also at two or more sets of trims, varied also by shifting the ballast.

The data thus derived may then by appropriate laws of relationship be used in connection with

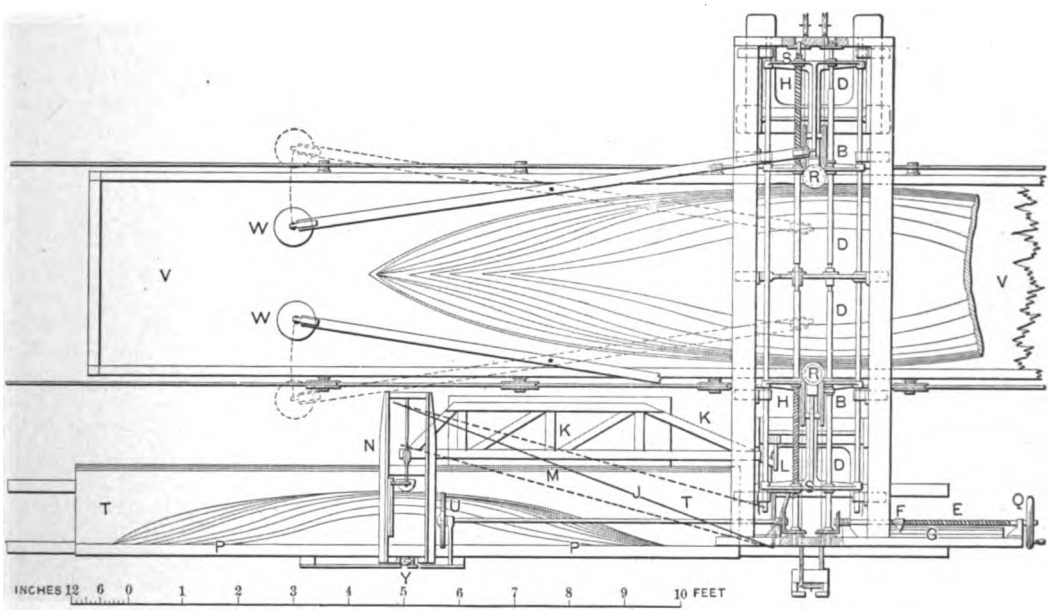


FIG. 1.—PLAN OF SHIP MODEL SHAPING MACHINE.

every ten feet. As an independent determination of speed through the water, use is often made also of a small carefully calibrated propeller wheel mounted on the truck and immersed in the water, the determination of the resistance of a ship of any size having the same form, and moving at a properly related speed. It may be well to note here that there seems to be no simple relation be-

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tween the total resistance of the model and that of the ship, so that of the total resistance considered as of two kinds, skin resistance and wave-making or residual resistance, the former is usually computed both for the model and for the ship by accepted empirical formulæ, and the latter from the model by the law of relationship for this part of the resistance.

These operations naturally give simply the tow-rope or natural resistance. Due to the interaction between a ship and her propeller, the actual resistance in the case of the combination is quite different from the resistance found as described above. For the determination of the resistance of a model combined with screw propeller, an additional separate truck is required carrying the latter and provided with means for running the propeller steadily at any speed in definite proportion to the speed of the truck. The propeller truck is also provided with means for measuring the thrust developed by the propeller as well as the power required to run it. These items as well as the revolutions are recorded on a drum or otherwise, so that a complete record may be determined of the items involved in the performance of the propeller as well as in the resistance of the ship. The two trucks are then attached together in such a position as to bring the propeller under the stern of the model and in the location it would occupy were it used as the means of propulsion. The propeller is nevertheless entirely unconnected with the model and can only influence it through the water about the stern. The two trucks with model and propeller are then moved at a given speed through the water, and the revolutions of the propeller are so adjusted that the thrust developed shall equal the resistance now shown by the model. The model and propeller are then, as nearly as may be, in the relation they would have, were the latter used for driving the former at the given speed in the usual way. The resistance thus shown by the model will be considerably greater than when towed alone, but whatever it may be, the thrust developed by the propeller can be made to equal it, and thus the conditions above noted can be obtained. Naturally these experiments will be repeated at varying speeds, and often with propellers situated variously relative to the model, and also of varying diameter, pitch, or surface.

For the investigation of propellers alone, the propeller truck only is used and the propellers are operated at a constant speed of advance and varying revolutions, thus giving varying slip. The thrust developed, the power absorbed, the revolutions and speed, are then determined and furnish the data for determining the performance of the propeller, including the useful work and the efficiency.

There are naturally many details of operation and refinements of manipulation which cannot be referred to in a brief article like the present, but these outlines will serve to show the nature of the problems involved, and the general way in which their solution is undertaken.

As already noted the data derived for any one case may by appropriate means be made applicable to an indefinite series of others, differing only in size and operated at properly related speeds. This is a most valuable feature of such investigations, for with the gradual accumulation of available data there is less and less need for independent experimentation concerning any given or proposed case. In the English Government experimental tank at Haslar there has been accumulated such a mass of data that most questions relating to cases likely to arise in common practice can be answered by interpolation from existing data without the need of individual experimentation, and the same in varying degrees is likewise true of the various other experimental establishments. There is, in fact, on file in the archives of these various establishments an amount of data which, if massed together, properly analyzed and reduced to common standards of measurement, would render unnecessary a vast amount of work which is currently carried on in the various places individually. The causes of this duplication are commercial and well known, and need not be here discussed, but emphasis may properly be laid on the resulting waste of effort arising from this continual working over of similar fields in different places, when by a combination of effort a large amount of such work might be saved.

Having available the store of data which such a combination would give, it would doubtless be possible to add notably to our scientific understanding of the general problem of resistance and propulsion. From the present state of our knowledge it seems unlikely that any purely analytical solution can be derived for these problems, and that we shall always be dependent on empirical formulæ derived from and expressing the results of experimental research such as we have here described. It is obvious then that the more complete the experiments as regards variety of form and conditions, the more satisfactory will be the formulæ developed, and the more will the future scientific study of the problem be furthered. While this combination of existing data is not likely to occur, at least at present, it has seemed desirable to point out the possibilities inherent in such a common storehouse, as well as the waste of energy which results from its segmentation as at present.

The lines of experimental research which we have thus far noted are those directly connected with commercial questions. There is in addition a large field of work of the very highest importance and which has been but imperfectly worked over. This consists of the more fundamental problems connected with the forces acting on bodies of elementary forms under varying conditions. Such, for example, are planes of varying size and form moved at varying speeds, immer-

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sions, and angles of obliquity with the course. Likewise bodies of elementary form such as the section of a propeller blade moved under varying conditions. There is in these and allied problems a vast field of work not related to any one commercial problem, but related to them all and to the whole subject in a very important and fundamental way. From the scientific standpoint, therefore, no work is at present more needed than a thorough and comprehensive examination of many of these questions, and no great advance in our theories of hydrodynamics as applied to such problems is likely to be made until the results of such investigations become available.

**Practical Applications.**

Many examples might be given of the value of the information determined by such experimental research. Of these, one mentioned in a recent paper read by Archibald Denny before the Institution of Civil Engineers in London and abstracted in Number 5 of this journal may be noted. In 1887 his firm, by the use of model experiments, was able to guarantee for side-wheel steamers for the Ostend-Dover route a speed of 20.5 knots or 1 knot in excess of the speeds previously obtained under like conditions. The firm thus obtained the contract, and in the result the vessels maintained a sea speed of about 21 knots.

15 per cent of the power, which, in such case, might be toward 1,000 I. H. P.

Experiments on the models of the Italian battle-ships Duilio and Dandolo, made long after their construction, showed that slight changes of model would have rendered the realization of the same speed and other conditions possible, with the saving of a considerable fraction of the power, or with a saving of nearly or quite enough money to build and equip an entire experimental establishment of the character previously described.

In this country during the early building of the new navy, premiums were paid amounting to over $3,000,000. The commercial value of these as an incentive to builders is not denied, but from the scientific standpoint it must be remembered that a considerable part of these sums might have been saved with the information available which an experimental tank could have furnished, and it is not too much to say that by the aid of such experiments the splendid results already achieved might have been even improved, or might have been obtained with a saving sufficient to have paid many times over the cost of the building and equipping of the experimental establishment necessary for their prosecution.

Of the possible and probable value of the information thus obtainable, there seems little room

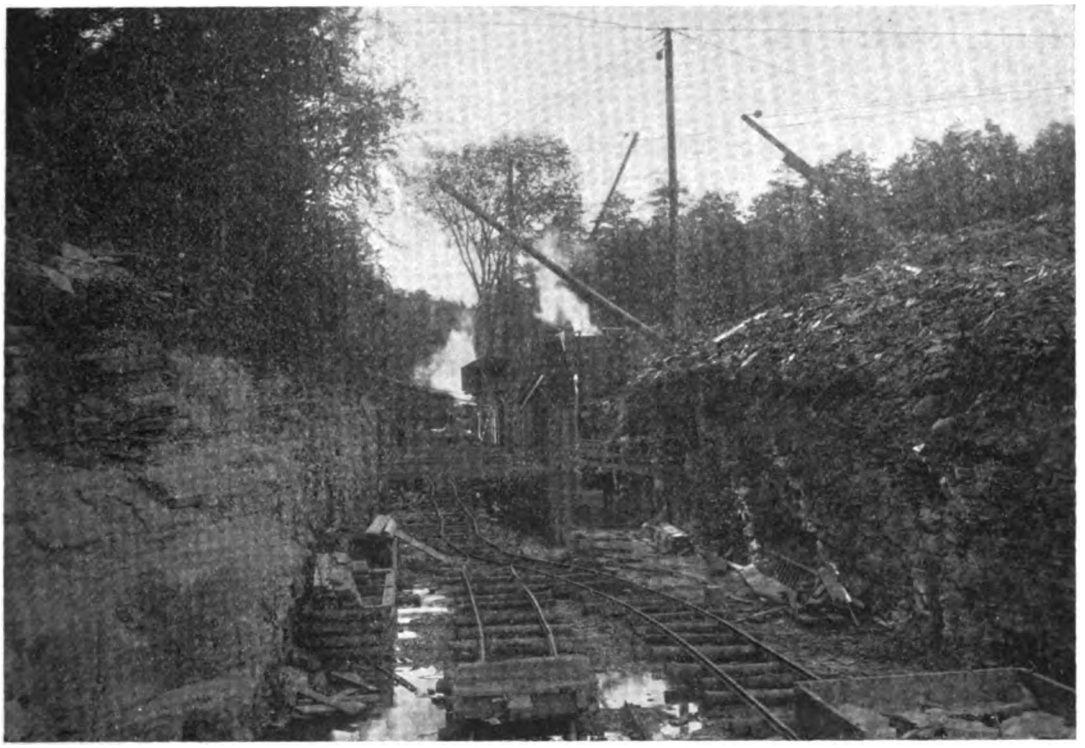

FIG. 3.—EXCAVATION FOR EXPERIMENTAL CANAL AT CORNELL UNIVERSITY.

Looked at in another way the value of this information may be seen by noting that, if content with 19.5 knots instead of 20.5, the former speed could have been obtained with a saving of perhaps

for doubt, and it may be hoped that as such possibilities are better realized larger sums than at present may be devoted to such purposes, and thus stores of information determined which shall

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be of still further and wider aid in these obscure features of the general art of marine construction.

**Historical.**

For many years in England and on the Continent the experimental investigation of models and general work along the lines here discussed has been held in high favor.

Between 1793 and 1798 Colonel Beaufoy made in the Greenland Docks in London his celebrated experiments in one part of the general scientific field, as noted above. In more recent years, between 1870 and 1880, the late William Froude carried on the same line of work, including his famous experiments on skin friction. He also first instituted in their present form the experiments on models, the first experimental tank being privately constructed at Torquay. The same line of work is worthily carried on by his son, R. E. Froude, in an establishment built by the British government at the Haslar gunboat yard, near Portsmouth.

Nearly contemporaneous with the elder Froude, Tidman, at Amsterdam, also conducted a notable series of experiments on skin friction and independently covered much of the same general field of investigation.

In more recent times experimental tanks have been established by the governments of Italy and Russia, while the French have long made use of similar experiments, carried on in a flooded dry dock or basin.

Still more recently the United States Government has appropriated money for such an establishment, which, as planned, will be the largest of any yet built, being about 500 ft. long by 50 ft. wide and 14 ft. deep. Of private establishments, Denny Bros., at Dumbarton, are alone in having instituted and maintained an experimental establishment of this character, and the success which has attended their efforts and the enviable reputation which they enjoy in the shipbuilding world are no doubt due in large measure to the information thus obtained.

Hitherto there has been no such experimental establishment in connection with an educational institution. There is, however, in process of present construction at Cornell University a general hydraulic laboratory, to be under the charge of the College of Civil Engineering. One feature of this laboratory will be an experimental tank or canal about 350 ft. long by 16 ft. wide and 10 ft. deep. In Fig. 3 is shown a general view of the excavation with stakes outlining the section of the canal. This, presumably, will be the only experimental establishment of its kind equipped for the prosecution of the lines of research discussed in the present paper, and without specific commercial relationships. The field of usefulness of such an establishment would seem to be wide and important, and it may be hoped that as a part of its work some of the many fundamental problems previously mentioned may be taken up, as well as those having a more definite commercial aspect and of more apparent present-day interest.

## THE UNITED STATES COMPOSITE ELECTRIC LIGHT VESSELS, NOS. 68 and 69.

Two interesting light vessels have just been completed by the Bath Iron Works, of Bath, Maine. The contract for the construction of these vessels was signed about the middle of January last, and the vessels were delivered to the Light House Board early in August, having thus been only about six months building. These vessels are by far the best light vessels afloat, and although very similar in general appearance to the new South Shore Light vessel—constructed last year by the same firm—they have many modifications, the principle points of difference being increased headroom in the living spaces, greater freeboard, better accommodation and superior arrangement of machinery. The contract price for the vessels was $74,500 each, to be delivered within nine months, and it will thus be seen that the contractors completed the vessels two months before the expiration of the specified contract time—a very creditable performance.

These vessels occupy the most important stations anywhere on the coasts. No. 68 is stationed at Fire Island, and No. 69 guards the Diamond Shoal off Cape Hatteras, one of the most dangerous spots in existence.

The dimensions of the vessels are as follows:

| | | |
|---|---|---|
| Length over all | 122 ft. | 10½ in. |
| Length load water line | 113 ft. | 1½ in. |
| Beam moulded | 23 ft. | 6 in. |
| Beam extreme to outside plank | 29 ft. | 5 in. |
| Mean draught with all weights, stores, coal, water, etc., aboard | 12 ft. | 6 in. |
| Depth of hold | 13 ft. | 3 in. |
| Depth moulded | 22 ft. | 1½ in. |
| Least freeboard t main deck | 3 ft. | 4½ in. |
| Least freeboard to spar deck | 11 ft. | 4 in. |
| Freeboard forward | 19 ft. | 3 in. |
| Freeboard aft | 13 ft. | 4½ in. |
| Overhang forward | 1 ft. | 8 in. |
| Overhang aft | 8 ft. | 5 in. |
| Tumble home to main deck | | 3 in. |
| Tumble home to spar deck | 1 ft. | 8½ in. |
| Proportion length to beam | 3.85 | |
| Proportion length to depth | 5.11 | |
| Proportion length to draught | 9.05 | |
| Proportion beam to depth | 1.33 | |
| Proportion beam to draught | 2.35 | |
| Displacement to load water line | 590 tons. | |
| Co-efficient of displacement, about | .5 | |
| Area immersed midship section | 279 sq. ft. | |
| Co-efficient of area of midship section | .76 | |
| Area of load water plane | 2,520 sq. ft. | |
| Co-efficient of load water plane | .76 | |
| Tons per inch at load water plane | 6 | |
| Area of wetted surface | 4,095 sq. ft. | |
| Area of immersed longitudinal section | 1,345 sq. ft. | |
| Rudder area | 44.6 sq. ft. | |
| Ratio of rudder area to immersed longitudinal section | 1 to 30 | |

These light vessels are of composite construction, the scantlings being very heavy and the structure unusually strong. The frames are composed of steel angle bars 4 1-2 in. by 3 in. by 9 lbs., spaced 18 in. from center to center. The floor plates are 18 in. in the center and are composed of plate 15 lb. per sq. ft., the reverse bars being 3 in. by 3 in. by 7 lb., run alternately to 3 1-2 in. above the main deck, and to 12 in. above the upper turn of bilge. Extra stiffening is afforded by four belt frames on each side, 12 in. wide with double 2 1-2 in. by 2 1-2 in. by 5 lb. angles on the inside, the plates being 12 1-2 lbs.

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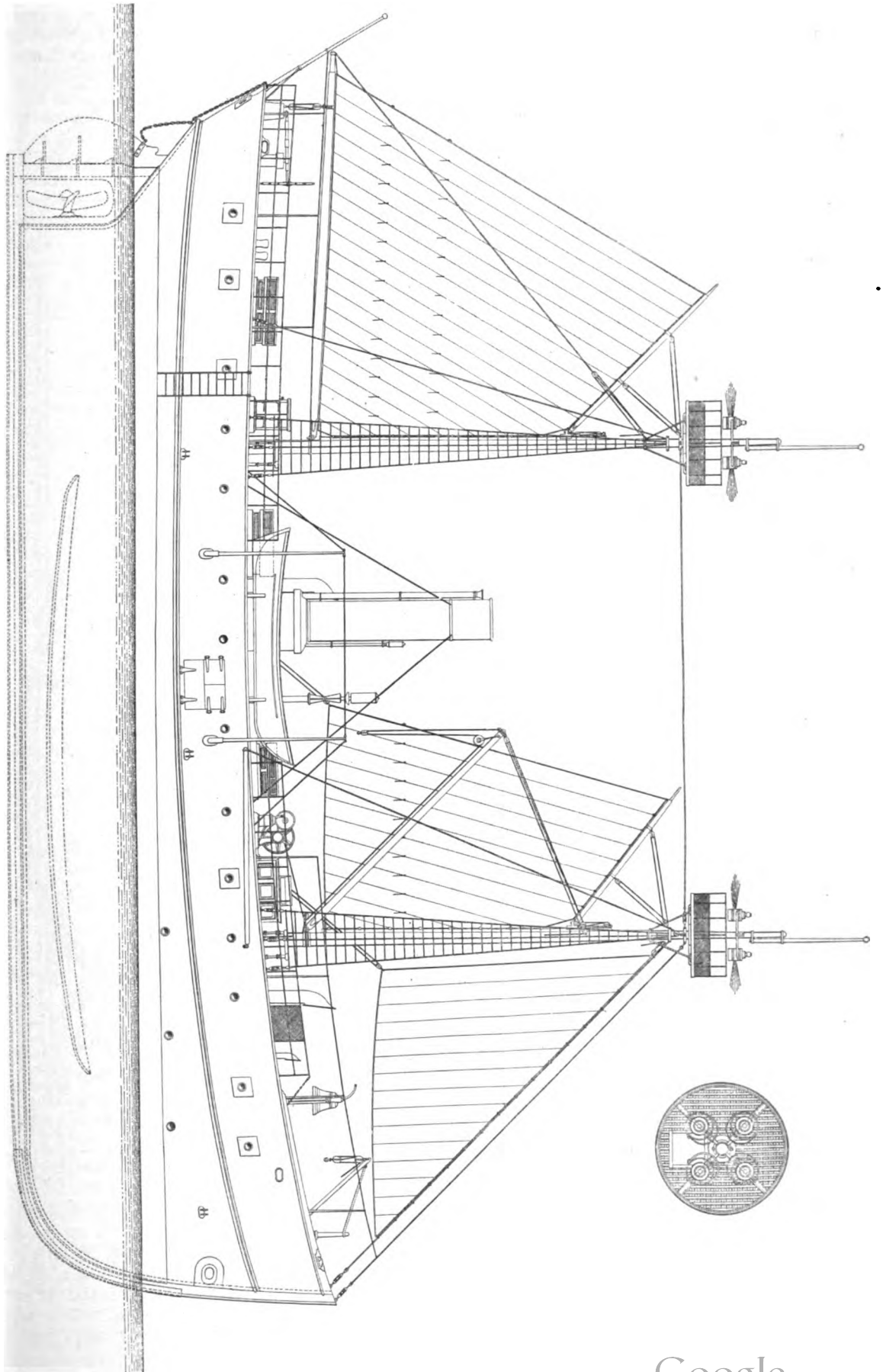

U. S. GOVERNMENT COMPOSITE ELECTRIC LIGHT VESSELS NOS. 68 AND 69, STATIONED AT FIRE ISLAND AND DIAMOND SHOAL.

*(Constructed by the Bath Iron Works, Bath, Me.)*

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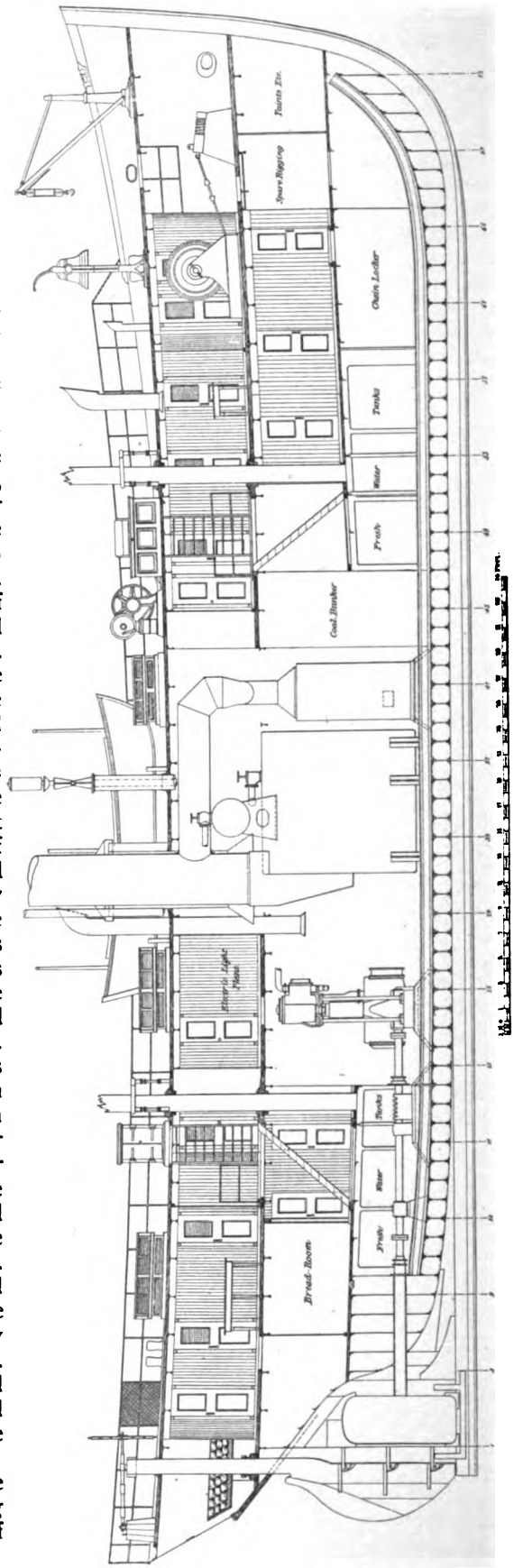
per sq. ft. above the floors. There is a steel flat plate keel 36 in. by 20 lb., and connected to this is a yellow pine keel 12 in. by 12 in., with two white oak false keels secured to it, one being 3 in. by 12 in., and the other 2 in. by 12 in. The vessels are planked with yellow pine to about 2 ft. above the main deck. The plank diminishes in thickness from 5 in. at the keel to 4 in. on the sides, the width of strake amidship varying from 15 in. garboard to 10 in. and 8 1-2 in. bottom and bilge strake, and 6 in. on the side. The vessels are then sheathed with 1 1-2 in. of white oak to the 14 ft. water line, and sheathed with copper to about the 13 ft. 6 in. water line. The sides of the vessels are plated with steel 12 1-2 lb. plates from 3 ft. below the main deck to the upper deck. The vertical keel or backbone of the vessel rests on the floors, and is 11 in. by 20 lb. riveted to the floors and to a horizontal flat keel or rider plate which is 24 in. by 20 lb., by double 3 1-2 in. by 3 1-2 in. by 9 lb. angle bars. On the upper part of the vertical keel are also a couple of angle bars 3 in. by 3 in. by 7 lb., and to these are riveted a 6 3-4 in. by 15 lb. plate. There are two side keelsons composed of 15 lb. intercostal plates riveted to a shell tie plate by 3 in. by 3 in. by 7 lb. angles, and to a 7 in. by 3 in. by 16 1-4 lb. angle bulb and a 3 1-2 in. by 3 in. by 7 1-2 lb. angle bar on the inboard edge. Additional fore and aft stiffening is afforded by two keelsons composed of 3 1-2 in. by 3 in. by 7 1-2 lb. angle bars riveted back to back, which are located one above and one below the main deck and about four feet from it. The main deck beams are composed of angle bulbs 7 in. by 3 in. by 18 1-2 lb., and spaced 36 in. apart. They have a camber of 7 in. in 28 ft., and are securely fastened to the frames by 18 in. by 18 in. by 17 1-2 lb. brackets or gusset plates. The spar or upper deck beams are formed of 6 in. by 3 in. by 13 3-4 lb. angle bulbs alternately spaced 36 in. apart and secured at ends to the frames by 15 in. by 15 in. by 15 lb. bracket plates. Both the main and spar decks have a metal waterway about 10 in. wide. Both decks have steel stringers and tie plates, the main deck stringer being 32 in. by 15 lb., and the spar deck 21 in. by 15 lb. Bilge keels are worked for a length of 60 ft. amidship. They are of white oak 20 in. deep and 6 in. wide at the outboard end. The main deck plank is 3 1-2 in. white pine and the spar deck plank is 3 in. by 3 in. yellow pine. A lower deck is worked forward and aft of the machinery spaces. The beams are 4 in. by 3 in. by 7 1-2 lb. angle bars, without any camber, and the deck plank 2 1-2 in. by 3 1-2 in. yellow pine. The bulkheads are all composed of 12 and 10 lb. plates stiffened vertically and horizontally with 3 in. by 2 in. by 5 lb. angle bars.

The stem, stern post, deadwood and rudder are all of white oak and extra heavy. The foregoing particulars are sufficient to show that the hull of



LONGITUDINAL SECTION OF U. S. GOVERNMENT COMPOSITE ELECTRIC LIGHT VESSELS NOS. 68 AND 69.

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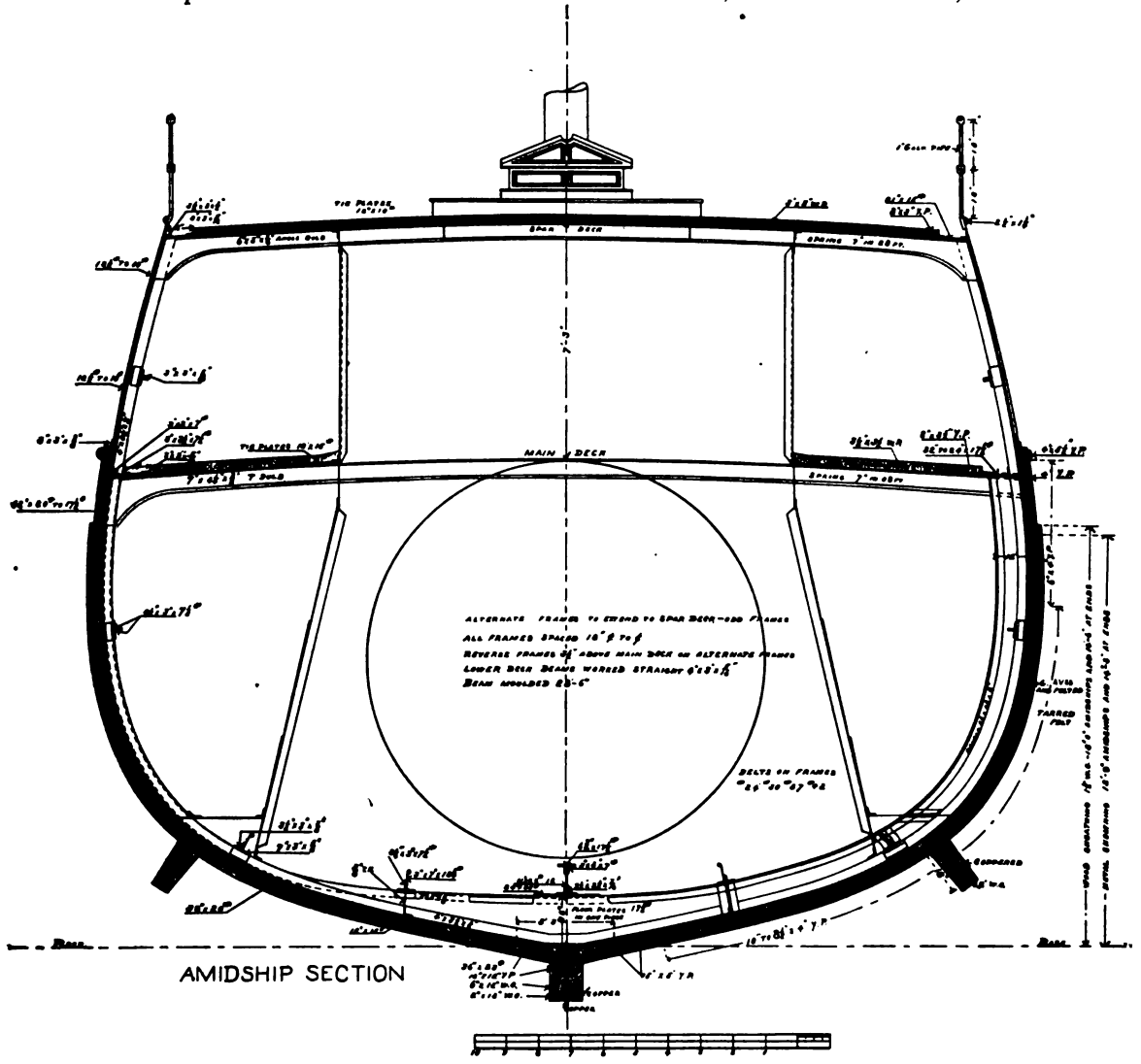
the vessel is very heavy, and the weight is judiciously located, so that the structure is unusually strong. The steel in the hull weighs about 200 tons and the launching weights of these boats was about 275 tons, the draught being nearly 8 ft. mean.

The officers and crew are all accommodated on the main deck. Forward is located the windlass with a lamp room and pantry on the starboard side, whilst the crew's wash room and W. C. is on the port side. Then comes the crew's quarters, and their accommodation is very fine and greatly superior to that enjoyed by the ordinary sailor. There are five spacious state-rooms with double




CROSS SECTION OF U. S. GOVERNMENT COMPOSITE LIGHT VESSELS NOS. 68 AND 69.

pipe berths 6 ft. 3 in. by 2 ft. 6 in. in each room. The galley is on the starboard side. It contains a range with a capacity for 20 men, a large wooden lead-lined sink, with a 4 in. brass pump connected with fresh water tanks, shelving, drawers, sacks, hooks, tables, coal box and all desirable fittings. The crew's mess room is quite large and airy, finished in white pine with hardwood trimmings, the mess table being 8 ft. by 3 ft., surrounded with substantial ash dining chairs. The engine and boiler casings take up considerable room amidships on the deck, the dynamo room being at the after end. Ten 18 in. coal scuttles lead to the bunkers, thereby enabling them to coal either from the main deck through the cargo side ports or from the spar deck by means of canvas chutes (there being scuttles in the spar deck over those in the main deck). Aft on this deck is the officers' accommodation, all partitions being of well-seasoned white pine. There are four state rooms, two on each side, furnished with hardwood, each state room having one berth with drawers underneath, a wardrobe, washstand and racks. The captain's room, forward on the starboard side, and also the engineers' room on the port side, have each a hard wood desk. On the port side aft is the pantry, and on the starboard side a chart and signal room, whilst the officers'

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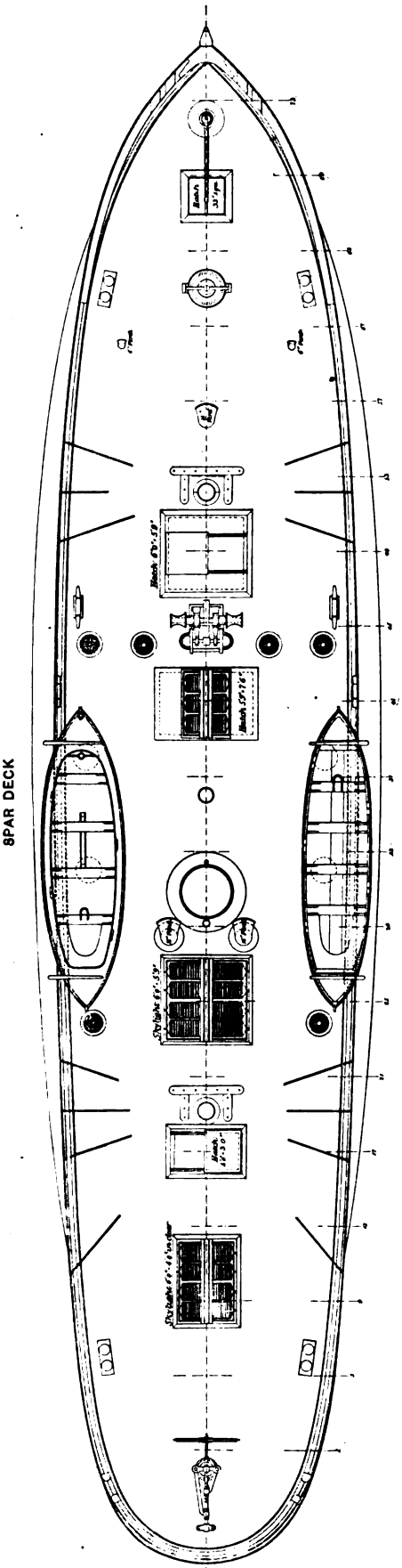


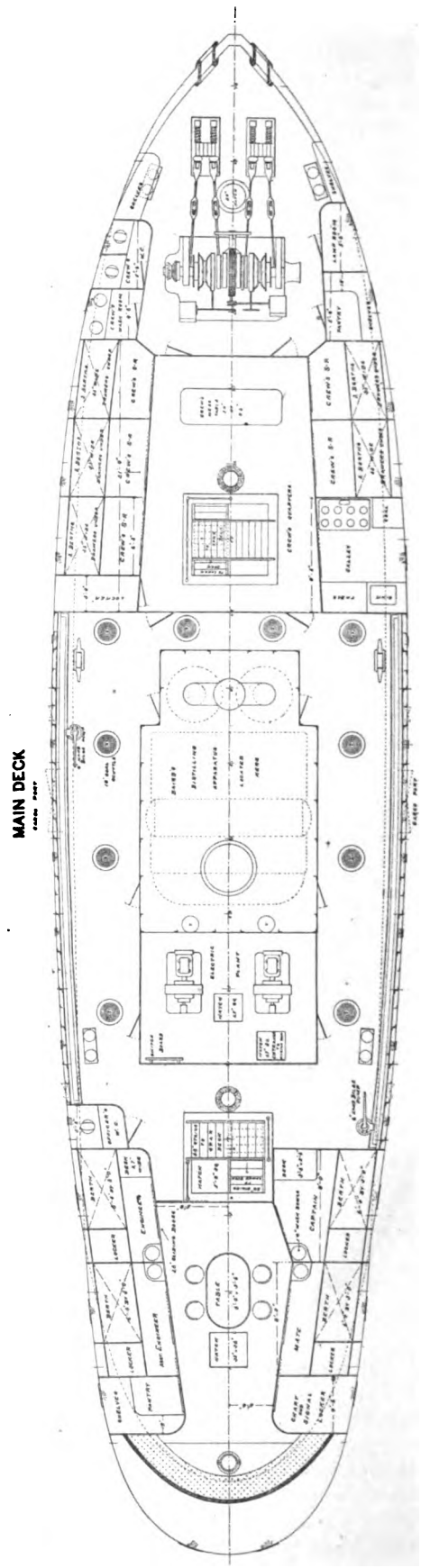


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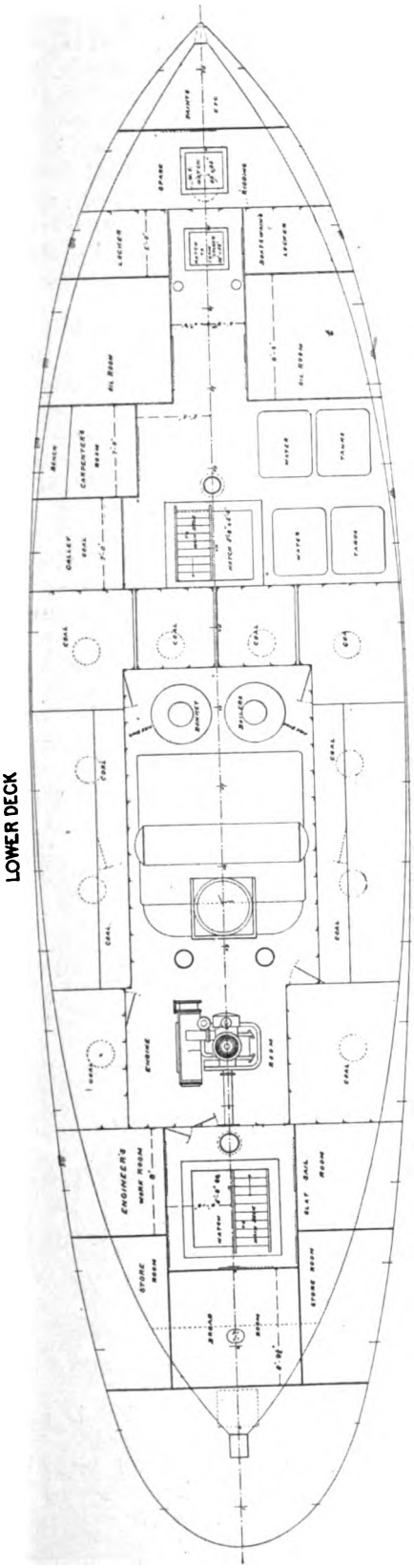


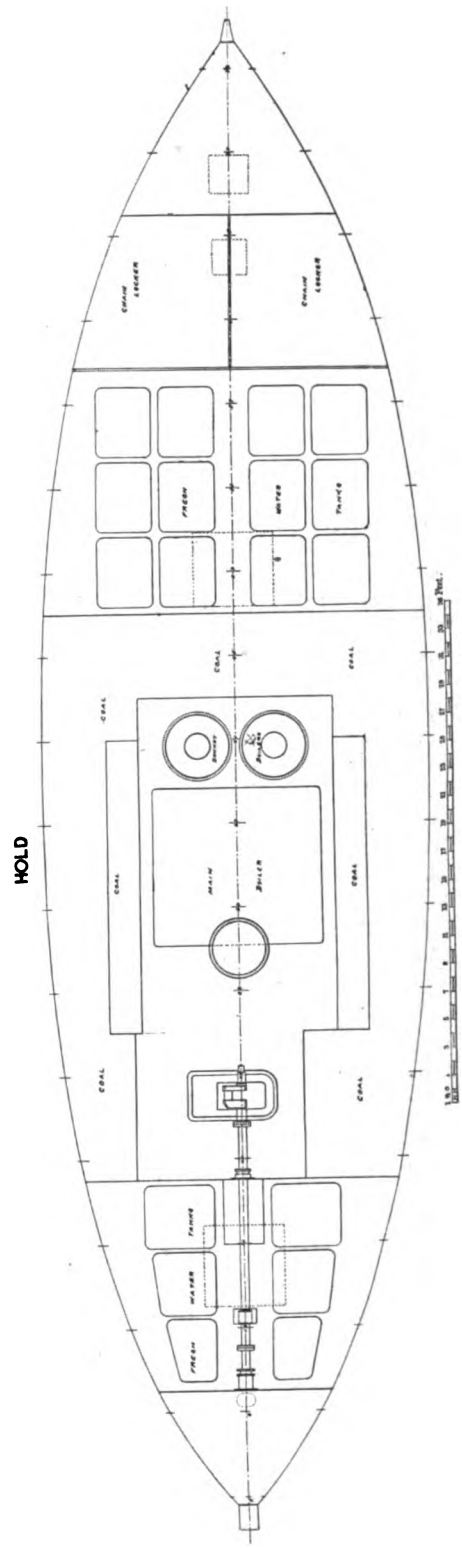


PLANS OF THE U. S. GOVERNMENT COMPOSITE ELECTRIC LIGHT VESSELS NOS. 68 AND 69, STATIONED AT FIRE ISLAND AND DIAMOND SHOAL.

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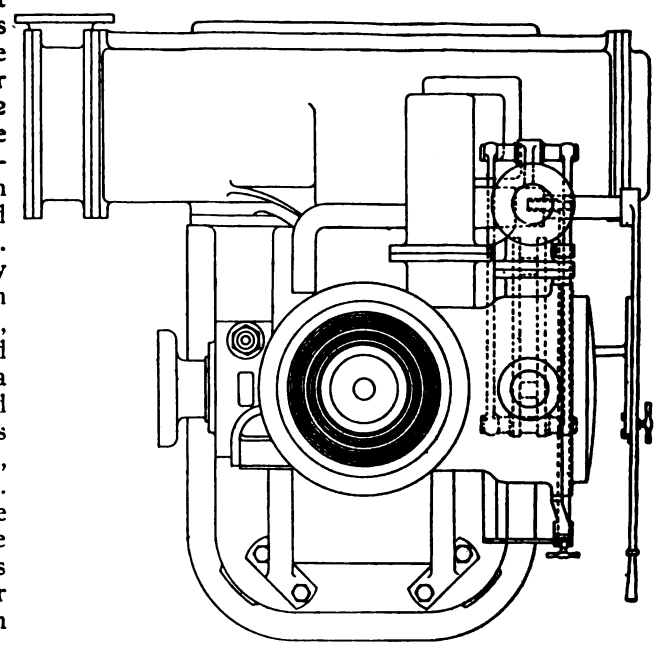
W. C. is forward of the engineers' room. A transom seat is worked around the stern. The floors are covered with linoleum and rugs, and all the fittings are very tastefully and neatly arranged. The officers' mess table is 6 ft. by 3 1-2 ft., and four leather-covered dining chairs have been furnished, together with a sideboard of artistic design. The lower deck is principally devoted to stores. Forward are the rooms for paints, oils, spare rigging and boatswain's gear. The carpenter has also a commodious work room with bench, whilst a space 7 ft. sq. on the port side is used for the stowage of galley coal. On the starboard side four large fresh water tanks are situated. Aft of the machinery spaces come the engineers' work room, which is entered from the engine room, a sail room, bread room, and two store rooms for miscellaneous stores. In the hold forward are twelve fresh water tanks, whilst aft six more large tanks are located. The entire hold space (excluding machinery and chain locker spaces) is devoted to the fresh water tanks. One of the best features of these boats is the fact that they are fitted with propelling machinery and power sufficient to take them to and from their respective stations, and in case the anchor cable breaks, they are not helpless.

The propelling machinery on these boats, although not used very much, is very complete. Economy is not essential, but initial cost, weight and space occupied. Especially the cost has had to be considered. The main engine is of the vertical inverted direct-acting single cylinder type. The steam cylinder is 20 in. dia., with 22 in. stroke, combined in one casting with the valve chest. It is supported upon two solid wrought-iron columns in front and one hollow box column extending from the top of the condenser, and forming part of the condenser casting at the back. The main distribution steam valve is an ordinary D slide, operated by a double bar Stephenson link, and a link block connected to the valve rod, which is guided by a bearing in an arm bolted to the valve chest. The engine is reversed by a hand lever. The condenser is of box form, and contains 700 sq. ft. of cooling surface. It is served by independent air and circulation pumps, which have circulating sea and bilge sections. This engine will develop 350 indicated horse power at 150 revolutions. It occupies a space about 6 ft. 6 in. sq., and the engine room is 10 ft. 6 in. long and 12 ft. wide. The propeller is four bladed and of manganese bronze, cast in one piece, right handed, and is 7 ft. 10 in. dia., and a pitch varying from 9 ft. 6 in. to 10 ft. The blade area is about 28 sq. ft., and the weight a little less than 1,700 lbs., the maximum width of the blades being 30 in. Steam for the main engine is supplied by a single ended steel Scotch boiler at a working pressure of 100 lbs. The diameter of this boiler is 12 ft. 2 in. and the length 11 ft. 3 in. It has three 39 in. dia. corrugated Madden furnaces. The combustion chamber is 28 in. wide, with 5 in. water space between it and the back of the boiler. There are 320 2 1-2 in. tubes 8 ft. 5 in. long, spaced 3 1-4 in. vertically and 3 1-2 in. horizontally. There is one combustion chamber common to all three furnaces. There are eighteen stay rods about 2 in. dia., fourteen of which are about 11 ft. 7in. long, and the remainder about 8 ft. 4 in. long. The shell of the boiler is 5-8 in. thick, tube plates 9-16 in., back of combustion chamber 1-2 in., and furnaces 1-2 in. The total tube surface is 1,765 sq. ft.; total heating surface is 2,045 sq. ft.; calorimeter 10.91 sq. ft.; grate surface, 63 sq. ft.; ratio of grate surface to heating surface 1 to 32.43; ratio calorimeter to grate surface, 1 to 5.77.

There are also fitted two vertical tubular donkey boilers, which are capable of supplying all the steam necessary to work the steam windlass, electric plant, donkey pumps, fog signals, and also for heating purposes, or for all purposes except for supplying the main engine. A See patent ash ejector has been fitted, also a Crosby chime fog whistle with a 12 in. dia. bell fitted with Crosby improved balance valve. There is also a 6 in. dia. whistle for use while under weigh. A Hyde improved Robinson steering gear is fitted aft with a 60 in. mahogany wheel. A steam winch is located on the spar deck forward capable of lifting about 3,000 lbs. A large clear-sounding bell of 1,000 lbs. weight has also been furnished, and this is mounted in a large belfry on the forward spar deck. The windlass is a steam pump brake Hyde windlass, with two Hyde double spring riding stoppers. The vessels are each equipped with the following anchors and chains: One mushroom anchor weighing 5,100 lbs.; one bower anchor, 2,000 lbs.; one kedge, 335 lbs., and two



PLAN OF LIGHT VESSEL ENGINE.

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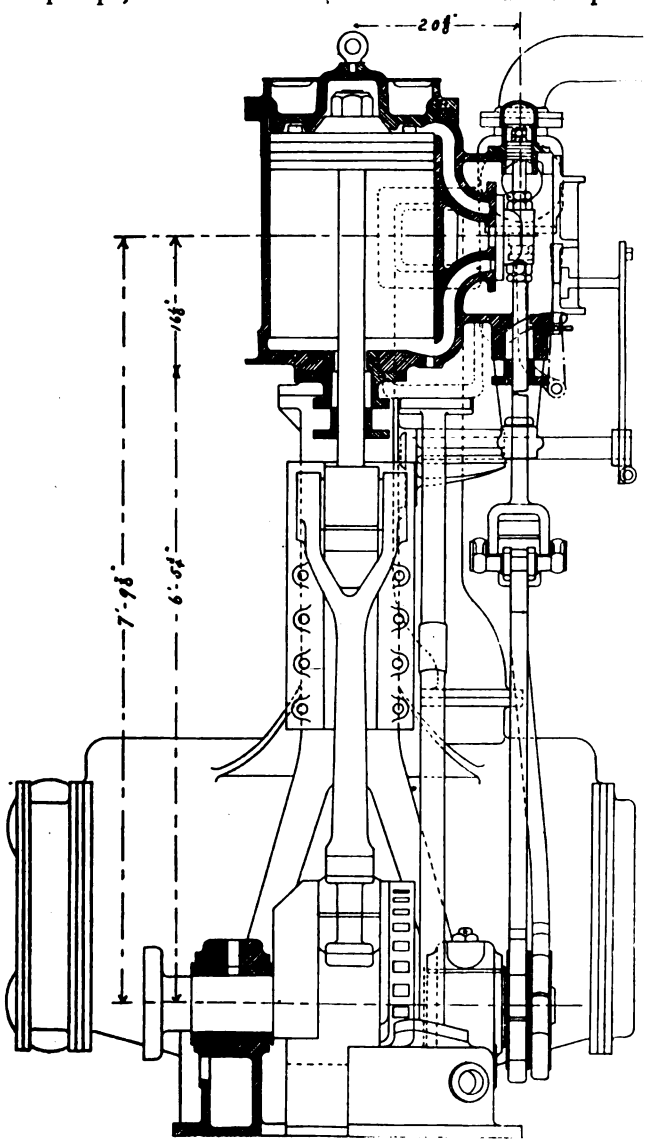
stud link chain cables, 120 fathoms each, 1 5-8 in. dia. The windlass on these vessels is placed in the center of the deck, and the hawse pipes (which are 11 in. dia.) are in the line of the direct lead from the wildcats, and in this respect they differ from their predecessors, which had a large hawse pipe in the stern resembling a torpedo tube. The ships are drained by 2 1-2 in. and 3 in. pipes, leading from each compartment to a manifold in the engine room, which is connected to a steam pump and also to two Hyde No. 3 deluge hand pumps, located on the main deck amidships.




LIGHT-VESSEL SIMPLE CONDENSING ENGINE.

There is also an automatic steam syphon in the engine room.

Two small boats have been supplied. One is a center-board of whaleboat model, 24 ft. long, 6 ft. 7 in. beam and 3 ft. deep. It has two masts 22 ft. 6 in. and 16 ft. 6 in. respectively; the foresail is a lug sail and the main mast carries a boom sail. The other boat is a corrugated steel Ingersoll self-righting, self-bailing and unswampable metallic life boat 27 ft. 6 in. long and 6 ft. beam. Both are carried resting in chocks on the spar deck of the vessel.

The water tanks of these vessels have a capacity of about 16,000 gallons of water, and the bunkers have a capacity of about 150 tons of coal. There are two spars built of steel, the total height of each with flag pole is 73 ft. above the load water line. Excluding the flag pole the height is about 64 1-2 ft. The spars have a diameter of 16 in. at the deck, and they have no rake. At the masthead is fitted on each mast a gallery for day signals to surround the electric lanterns. The frame work is of steel with wood grating floors, gas pipe railing and netting of galvanized wire. A large coaling boom is fitted on the foremast and a boat boom on the starboard side abreast of the forward rigging. The main boom is about 40 ft. long and 11 in. dia., and the fore and main gaffs are about 21 ft. long and 6 in. dia. The total sail area is 1,805 sq. ft.

The electric plant is in duplicate, being composed of two General Electric marine sets, known as M. P. 4-8-650, with 4 1-2 by 4 in. double cylinder General Electric engine. The vessel has forty lights of 100 volts 16 candle power, and eight 100 volts 100 candle power lights at the masthead, four on each mast. Attached to the engine and dynamos is a device for alternately opening and closing, at regular intervals, the circuits at the masthead lights. This device is arranged so that the length of the intervals may be varied from five to twenty seconds at will. There has also been furnished on each vessel an automatic machine for operating the fog signal whistle, also an automatic registering device.

These vessels are excellent sea boats. They roll quite easily and have full buoyant ends. They have good freeboard and an enormous reserve buoyancy. These vessels have had no speed tests, but they have averaged 8 1-2 knots for 20 or 30 hours; steaming at sea with about 275 horse power, and a displacement of about 480 tons.

The Bath Iron Works have just laid the keel of another light vessel, No. 71, for Overfall Shore, New Jersey. This will make the fifth vessel this firm has built for the U. S. Light House establishment in two years, besides doing extensive repairs and alterations on the light-house tenders Armesia, Myrtle and Lilac. The construction of these vessels was carried out under the personal direction of Charles R. Hanscom, naval architect and shipyard superintendent, with the aid of Charles E. Hyde, consulting engineer; John S. Hyde, superintendent engineering department, and William C. Besselievre, assistant superintendent of the ship department.

During the construction of these vessels S. A. Savage represented the Light House Board, and inspected the work as it progressed.

The placing of a light vessel on the Diamond Shoal is largely in the nature of an experiment; and results are awaited with interest.

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## PITTSBURG AND CINCINNATI PACKET LINE STERN WHEEL STEAMER QUEEN CITY.*

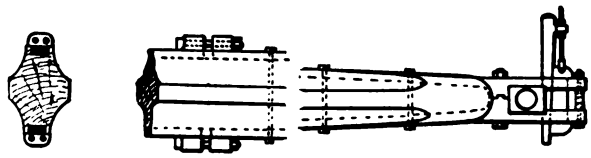
BY BERT L. BALDWIN, M.E.

The machinery which propels the steamer is on the main deck, and is so located as to distribute the weight through the length of hull. Just aft of the main hatches are the boilers which supply steam to the main engines, as well as the various auxiliaries. Dimensions of the boiler are fixed by Government rules, and on account of the great amount of mud in the water, when there is a rise in the river, there must be a space of at least 3 in. between all flues or tubes. In building the boilers for the Queen City, certain concessions were granted, and the steel plates were increased in thickness 2-100 in. over the usual standard, which, together with a high tenstile strength, permitted a slight increase in the diameter of the shells, as well as in the steam pressure.

There are four boilers of the horizontal return flue type, externally fired. They are made of Luken's marine steel, having a tensile strength of 70,000 lbs. per sq. in., and an elongation of 30 per cent. in 2 in. Each shell is 47 in. dia. by 26 ft. long, 28-100 in. thick, with all longitudinal seams double riveted, and circumferential seams single riveted. The heads, or flue sheets, are 5-8 in. thick, flanged for shell and flues. These are six in number, lap welded, telescoped in six lengths and made one gauge heavier than the usual standard. These flues are riveted to the flue sheets, and act as braces. The flue sheets are also braced above the upper line of flues by crow foot braces. These flue sheets are re-inforced around all man and hand hole openings. The four boilers are connected together by one 24 in. dia. by 18 ft. long steam drum, having flanged steel connecting legs 16 in. dia., and spacing the boilers so that there is 10 in. flame room between the shells. The boilers are also connected together by two mud drums, which are 16 in. dia. by 18 ft. long, and connected by 8 in. dia. water legs. The boilers are supported by the mud drums, which, in turn, rest upon cast-iron stands, which are secured to the iron deck plates.

Boilers of this type require a setting very similar to the ordinary land boiler, but as the settings must be as light as possible, the brick work is kept down to a single thickness of fire brick, supported by a sheet-iron casing, which incases the boilers up to the water line. The ash pan is of 1-4 in. thick steel plates, with a flanged rim rising 8 in. high above the deck. This is paved with fire brick, laid in Portland cement, and is fitted with a 10 in. dia. ash well, which extends from the surface of the paving directly through the bottom of the boat. The boiler fronts are cast iron, with large fire doors and ash pit openings, and with movable grate bars arranged so that they can be replaced without disturbing the fire to any extent. The grate extends from side wall to side wall under all four boilers, making the grate 20 ft. in width by 4 ft. 6 in. in length. As will be noticed by reference to the boiler settings on page 19, the fire bed at the bridge wall is brought up to within a few inches of the boiler shell, and this distance is increased at the other end, so as to form an easy curve for the gases as they enter the flues. The back arch and all exposed portions of the boiler and drums are covered with asbestos cement to a depth of 3 in. The breeching and chimneys are made of cold rolled iron, and supported under the large elbows by pipe braces, not shown on the drawings, which transmit the weight to the steel boiler beam below deck.

Each boiler is supplied with a 4 in. dia. Government standard lever safety valve. The only known objection to this type of valve is the fact that the lever forms a splendid "roosting place" for a heavy deck hand, when the engineer wants a little higher pressure than the weight and lever is proportioned for. Each boiler is also supplied with fusible plugs screwed in the shell, three Mississippi gauge cocks, in the back flue sheet, where they are convenient for the engineer. There is also a copper float which operates the black hand upon a white 10 in. dial, near the after end of boiler. There are, of course, reliable steam gauges in front of the boilers, as well as



DETAIL OF PITMAN OR CONNECTING ROD.

in the engine room. The blow-off valves are bronze and heavily protected. The boilers are fed through the top of the shell, the perforatetd brass feed pipe being carried down below the flues and extended well along toward the center of boiler.

Forward of the main boilers, in the starboard coal box, is located a 48 in. dia. by 8 ft. high vertical fire box donkey boiler, which is used for various purposes when the steamer is in port, and the main boilers cooled down. The entire boiler equipment was built and erected by the McIlvain & Spiegel Boiler & Tank Co., of Cincinnati, who make a specialty of "river work," and deserve credit for the excellence of their work.

From the outlet on the steam drum of the boilers, and extending into the engine room, is an 8 in. steam pipe, having all of its flanges bored and shrunk on to the pipe and properly secured by rivets. This pipe terminates at engine room end in a long radius fire bend, which is coupled to the throttle valve casting near the floor line. This is supported upon a roller stand, allowing for the free expansion and contraction of the steam main, as well as other strains that might be pro-

* Commenced in October issue.

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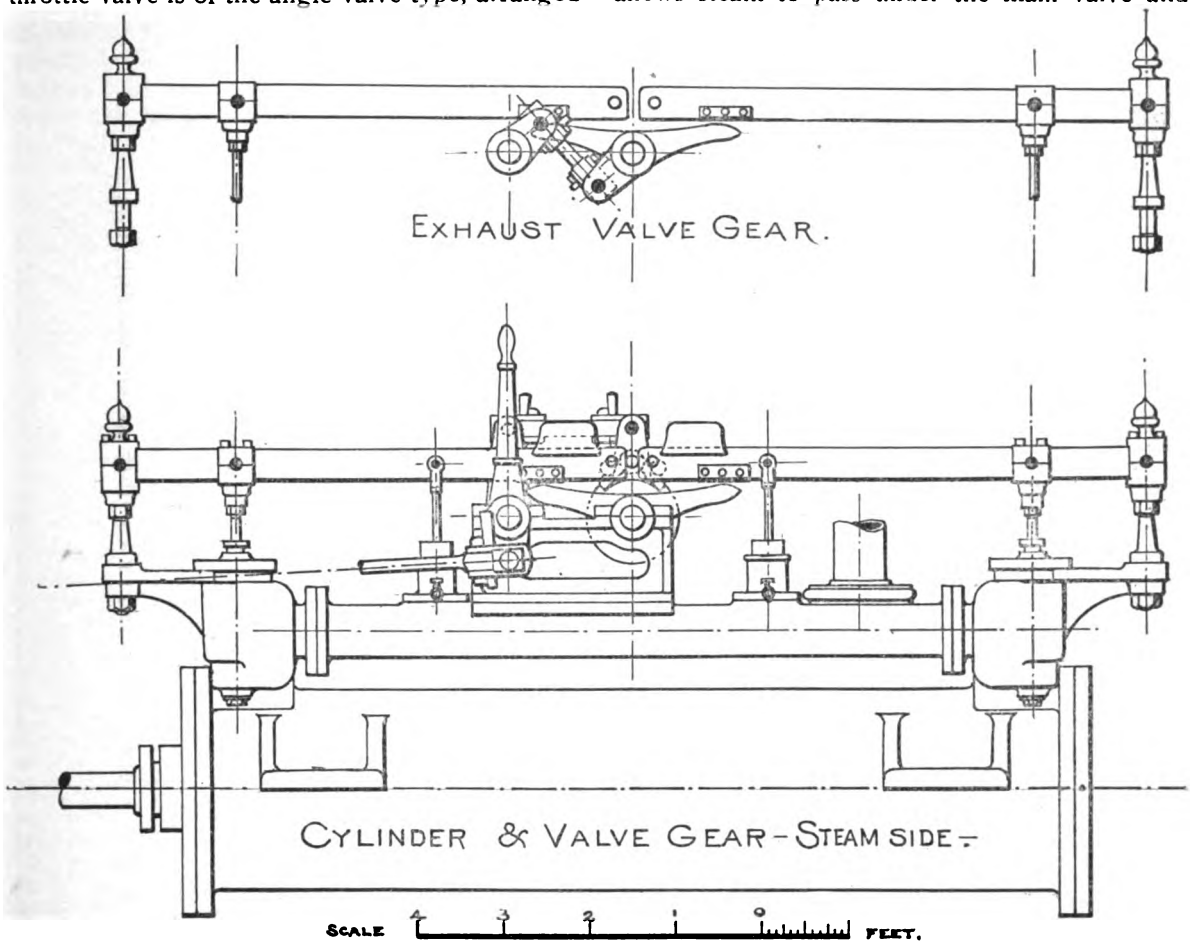
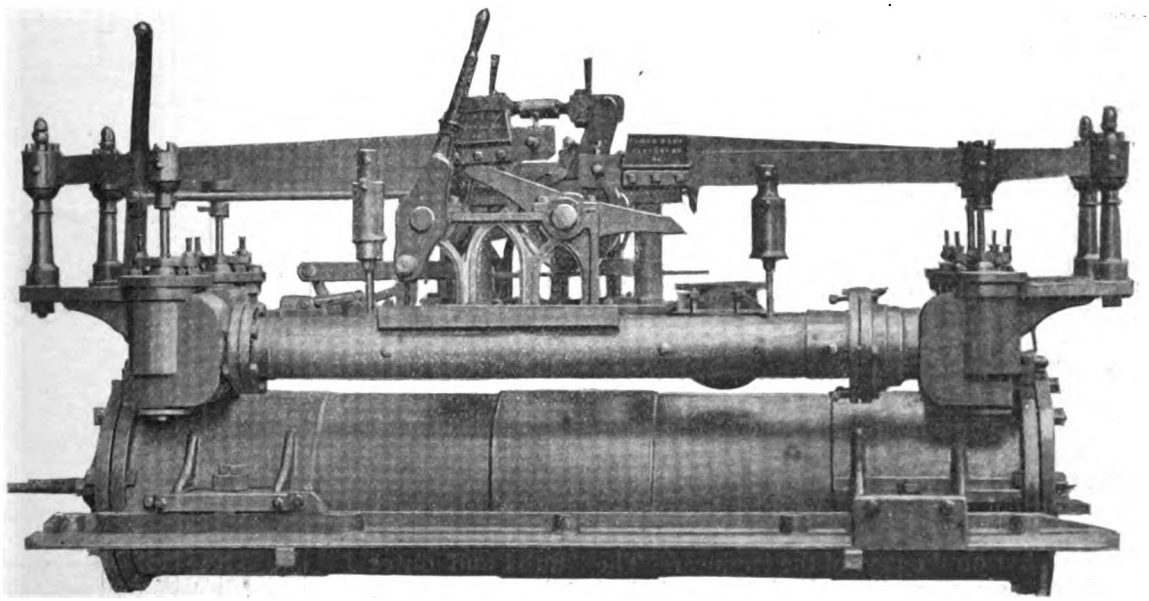
duced by the "twisting" of the steamer. The throttle valve is of the angle valve type, arranged so that in opening the valve against the heavy steam pressure a certain amount of lost play in the valve stem opens an auxiliary valve which allows steam to pass under the main valve and form a balance before raising the latter from its seat. Long radius fire bends connect the throttle




HIGH PRESSURE NON-CONDENSING ENGINES OF OHIO RIVER STEAMER QUEEN CITY.



TYPE OF ENGINE GENERALLY USED IN OHIO RIVER STERN WHEEL STEAMERS.

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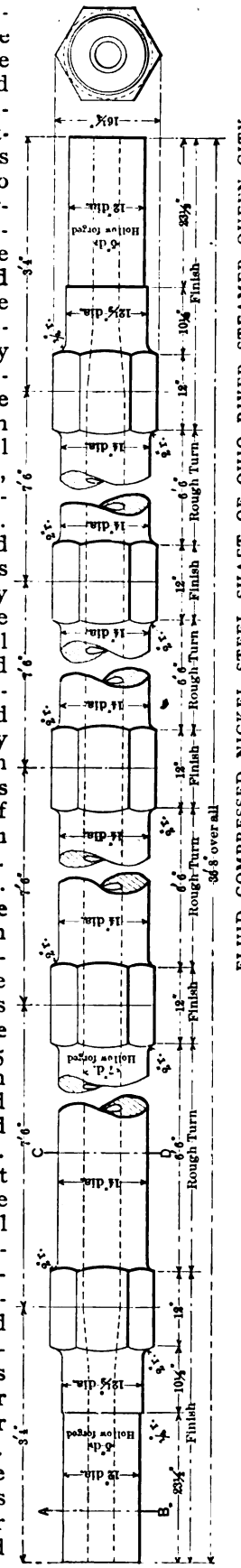
casing with the main engines, and other steam pipes lead away from this casing to supply the electric light engine, water pump, reversing gear and steering gear.

The main engines which propel the boat are two in number, of the simple high pressure type, with cylinders 24 in. dia. and 96 in. stroke, placed close to the guards and overhanging the stern, as shown on the plan. The general design of these engines is about the same as has been used for many years in this service. Certain slight modifications have been made, so that the engines give satisfaction on account of their free action, accessibility, and the ease with which repairs can be made—a very important matter in case of a breakdown miles away from a machine shop. Each engine has a steam cylinder 24 in. dia. by 96 in. stroke, having four double beat poppet valves, designed so as to be practically balanced, and connected to the weighted lifting bars, fitted with suitable "dash pots," as shown in the sketch of valve gear on page 17. The steam valves, with their side pipes, are located on the inboard side, while the exhaust valves are on the outboard side of the cylinder, and are operated by separate rocking cams, which receive their motion, through rockers and connections, from an irregular shaped cam located on the paddle shaft, just inside of the main bearings. The motion transmitted is intermittent, so that the valves have a quick opening and closing action, with a long pause between these periods. The motion upon the exhaust valve is arranged so as to give uniform release and compression, while the steam valves are arranged so as to have a uniform lead, and by means of a releasing gear, a point of cut-off, which can be varied from 1-4 to 7-8 of the stroke. The releasing gear is tripped by a pair of adjustable stops, which receive their motion from the main cross head. This is known as the Rees cut-off gear. It is arranged so that the cut-off stops can be lowered, and not come in contact with the releasing catches, extending the point of cut-off to about 7-8 stroke, which is necessary in making landings or turning the wheel over at a slow speed. The cam rod is connected to a stationary reverse link of very simple construction, while the radial rod, which is connected to the valve rocker on the cylinder, is coupled to the link block, and this link block is shifted or held in any desired position by a small steam cylinder, suspended vertically over the link and coupled by suspension hangers. The valves of the reversing cylinders are controlled by a lever, which, together with the connections that regulate the cut-off stops, are near the throttle valves, so that the engines can be worked to varying points of the cut-off, ahead or astern, without excessive labor on the part of the engineer. The slide plates, as well as the cylinders, are bolted directly to the built-up engine timbers, with their centers as nearly in line with the top plates as possible. The cross heads are similar to the locomotive type, having long brass gibs which bear on top and bottom of the slide plates. The main outboard bearing is formed of heavy cast-iron pedestals let down into the upper surface of the projecting engine timbers, and carrying bronze liners held in position by heavy caps. The engine cranks are wrought-iron forgings well proportioned, smooth finished and painted. The crank and cross-head pins are 6 in. dia. by 6 in. long. The paddle wheel shaft is fluid compressed nickel steel, forged hollow, made by the Bethlehem Iron Co., and is the first one of this material on the Ohio River. It is 14 in. dia. and 12 in. in the bearings, with hexagonal bosses where the five wheel flanges are keyed. The central core is 5 in. dia. through the journals and crank fits, and enlarged to 7 in. through the rest of the shaft. The paddle wheel flanges are cast-iron, heavily ribbed pattern, reinforced by wrought-iron bands shrunk on their hubs and outer circumference. They have hexagon cores through their centers, dressed

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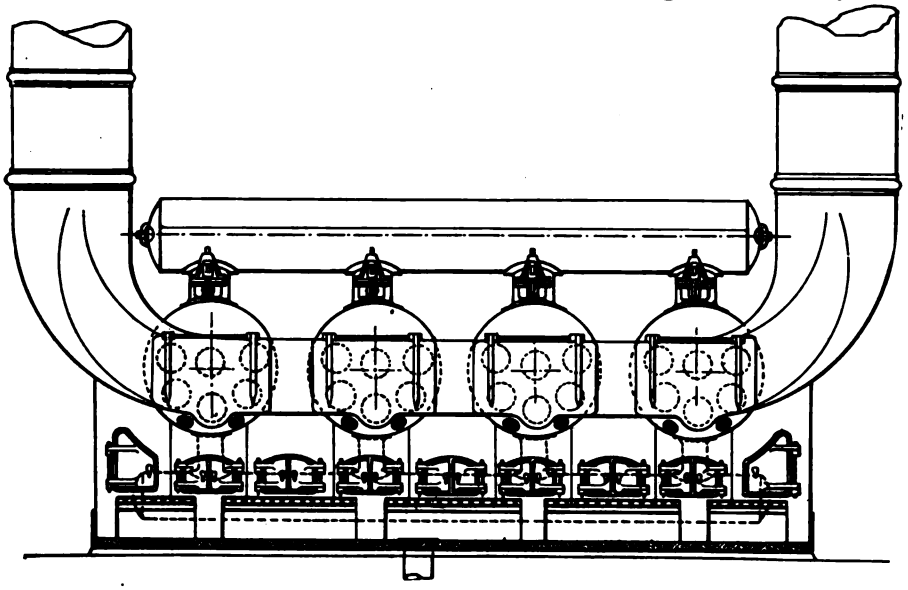
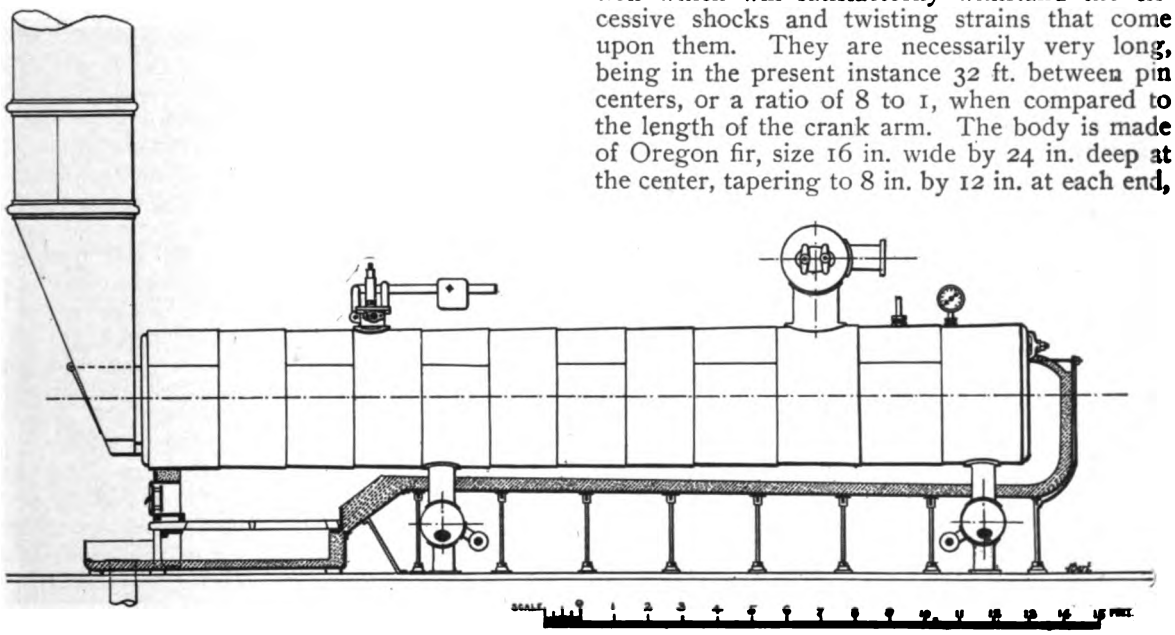
true, and each is secured to the shaft by means of 18 steel keys, fitted and driven in place. Four of the wheel flanges have sockets for a single set of arms, while the center flange is doubled and carries a double set of wheel arms. This is because the buckets are divided at the center so that they can be staggered, which greatly reduces the vibration caused by the buckets striking the water.

The buckets are made of 2 in. oak, 24 in. wide, and arranged to work 4 in. under water, when the steamer is running light. They are secured by 3-4 in. dia. U bolts extending around the wheel arms.

The connecting rods certainly look "antique," on account of their massive wooden bodies, but up to the present time this is the only construction which will satisfactorily withstand the excessive shocks and twisting strains that come upon them. They are necessarily very long, being in the present instance 32 ft. between pin centers, or a ratio of 8 to 1, when compared to the length of the crank arm. The body is made of Oregon fir, size 16 in. wide by 24 in. deep at the center, tapering to 8 in. by 12 in. at each end,



FRONT ELEVATION OF BOILERS OF STEAMER QUEEN CITY.



SKETCH SHOWING METHOD OF SETTING BOILERS OF STEAMER QUEEN CITY.

The paddle wheel is 24 ft. 6 in. dia. by 32 ft. long over buckets. The arms are made of clear 3 in. hickory, 7 in. wide where they enter their flanges and 10 in. wide at rim of wheel. These arms are strengthened by the circles and braces, which are bolted to and between them. lightened by being dressed to the section shown, and reinforced by the wrought-iron straps which are let into the body and through bolted. These straps are 2 1-2 in. by 4 in. sections, with brass pin boxes and steel gibs, keys, keepers and clamp bolts, as shown on the sketch on page 16.

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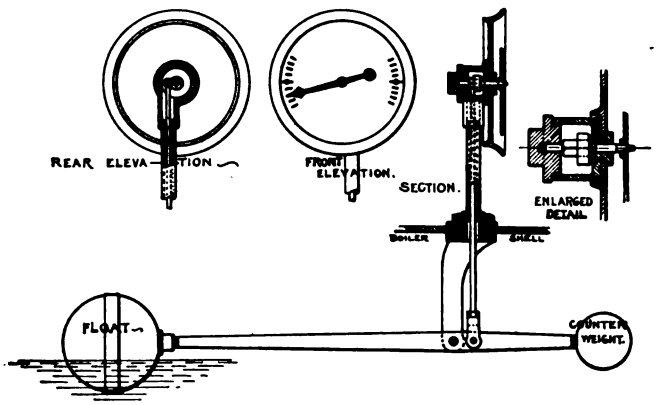
The exhaust from each cylinder is connected to a special three-way valve, by which it can be turned directly through the vertical exhaust pipes to the atmosphere, or through a central exhaust main which branches at the boiler so as to exhaust into and form a blast in the chimneys, or, in cold weather, discharge through stern pipes onto the paddle wheel and bearings, to prevent the formation of ice.

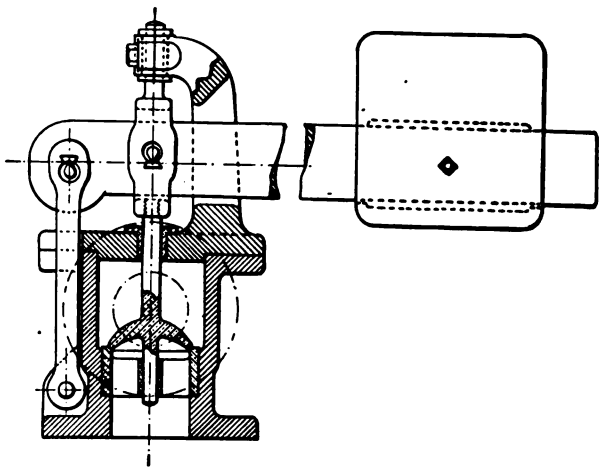
Situated just forward of the throttle valve, in the engine room, are two Lunkenheimer feed water injectors, with separate steam supply pipe, leading directly from the boiler, and each having separate suction and discharge connections. The water from these injectors is forced through a copper feed pipe, about 80 ft. of which is passed through the center of the exhaust main, forming an excellent feed water heater. Using injectors is quite a departure from the usual river practice, where the "doctor" was always considered a most necessary portion of the machinery outfit. This occupied a space about 4 ft. wide and 8 ft. long, with vertical steam cylinders, overhead beam,




WATER GAUGE AND CONNECTIONS.

connecting rod, fly wheel and numerous plunger pumps, which were always giving more or less trouble. As a further precaution, the duplex fire pump, 7 1-2 in. by 4 1-2 in. by 10 in., placed just aft of the boilers, is arranged so that it can be used for feeding them in an emergency. Government regulations also require a hand-power feed pump to be coupled up so that it can be used for both fire and boiler feeding purposes. There is a small duplex pump in the engine room, which has a pump governor connected to its steam pipe, set for 40 lbs. water pressure. This pump supplies water to a pressure tank suspended overhead, and, with the various pipe connections, forms the steamer's water works, maintaining a constant pressure upon the water mains, which supply the fixtures in the various wash and toilet rooms, as well as in the cook house, pantry and laundry.

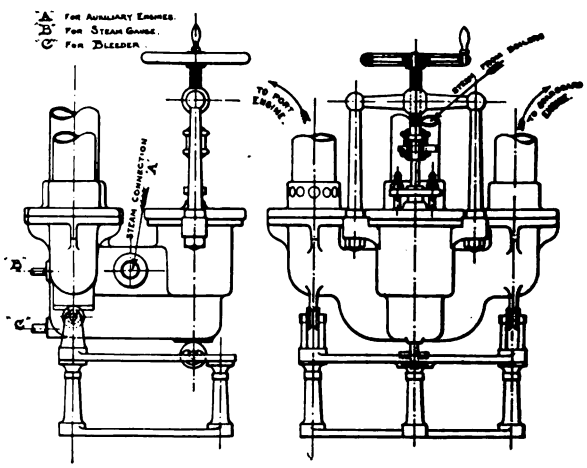
The electric lighting plant is also in the engine room, and consists of a slide valve engine, 10 in. by 14 in., with a very sensitive governor. The engine is placed athwartship and is belted direct to a 24 K. W. multipolar shunt wound dynamo, feeding a 120-volt circuit. The switchboard is in the center of the engine room upon a raised platform, and consists of a polished marble panel, held in position by a nickel-plated frame, and is equipped with volt and ammeters, pilot



SECTIONAL SKETCH OF SAFETY VALVE.

lamps, rheostat, ground detectors, as well as the main and the various circuit switches. The entire steamer from hold to side lights on the chimneys is lit up by electricity, not a single oil lamp being in use on the boat. There are about 300 16 C. P. incandescent lamps in service, the lighting system being divided into five circuits, each of which is controlled by a separate switch.

The circuits are divided thus: All night circuit, carrying lights on the main deck; staterooms; lights in barber shop; ladies' reception room; toilet rooms and texas; cabin electroliers and light clusters; ladies' cabin; lights in the hold and arc lamps on incandescent circuit. Of these there are two side lamps of 2,000 C. P., one




THROTTLE VALVE AND CONNECTIONS.

lamp of 2,000 C. P., one 800 C. P. enclosed lamp on the forward deck, and a 4,000 C. P. searchlight on the mast. All of the large arc lamps are under control of the pilot.

[*To be continued.*]

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## QUADRUPLE-EXPANSION ENGINE AT FIVE HUNDRED POUNDS PRESSURE.—I.

BY DR. R. H. THURSTON.

Rising steam-pressure has been one of the principal characteristics of progress in marine engineering, as in every other branch of steam engineering, from the first, and our knowledge of the science of thermodynamic energy-conversion shows us that it is the primary principle of economic progress. The extent and the rate of this increase in the intensity of the steam-pressures adopted by our most progressive and successful engine builders have been illustrated by the writer, perhaps most strikingly and most clearly, by a diagram which the ordinates are the pressures taken as standard at dates which are represented by the abscissas of the curve.[1] This diagram—Fig. 1, page 10,[2] in the April issue of Marine Engineering—is useful as indicating most satisfactorily the trend of progress in this respect in the operation of steamships at the moment. It represents probabilities for the immediate future also; although, of course, we have no assurance that some sudden change may not be brought about by the introduction of some new invention or the adoption of some as yet unanticipated improvement in construction, resulting in such sudden changes as characterized this curve when the steamship proprietor, twenty years ago, became convinced of the profitable character of the then comparatively unfamiliar multiple-cylinder engine.

It has long been known that this direction of progress must be adhered to with the steam-engine if we are to continue its improvement in the direction of increased thermodynamic efficiency. The conditions retarding progress are not those related to the theory of the case, but almost wholly those due to difficulties arising in the endeavor to avail ourselves of the promise of gain through the use of high-pressure steam. The two main obstacles to further advance under the old régime were the increasing internal wastes of the engine with increasing ratios of expansion proportional to the rising pressures, and the difficulties attending the construction and operation of boilers subjected to exceptionally great intensity of steam-pressure. The former of these obstacles was removed in large degree by the adaptation of the multiple-expansion engine to the use of the marine engineer, and the latter was evaded, first, by the use of the now almost universally employed "Scotch" boiler, and, recently, by the introduction at sea of the more manageable forms of the "water-tube" boiler. The compound engine brought up pressures from the two or three atmospheres pressure of the last generation to from four to five atmospheres, and the triple-expansion engine raised the figures to six or eight, and sometimes ten, in its earlier history, and to fifteen atmospheres later; while the quadruple-expansion has already made similarly successful pressures exceeding 200 pounds on the square inch, and seems likely, if we are to judge by the results of the experimental work to be here presently described, to make available pressures of from 250 to 500 pounds per sq. in., or upwards of 30 atmospheres.

These higher pressures, to become economically desirable, must be worked expansively throughout the greatest possible range of pressures and temperatures, and this expansion must be as nearly as possible perfectly "adiabatic." A cut-off at such a point as will insure expansion to a minimum terminal pressure—measured by the sum of condenser-pressure, loss of pressure in ports, the pressure equivalent to the mean effective friction-pressure of the unloaded engine, and a quantity determined by the extent of the internal wastes by "cylinder-condensation"—is that best suited to give maximum gain, and the reduction, and if possible extinction, of wastes of heat, internally and externally, by conduction and radiation, are the two primary conditions of maximum physical efficiency of the engine; while maximum net financial gain is still further limited by relative costs of improved apparatus and of fuel saved. General experience, under the conditions familiar to us in transatlantic navigation, has now led to the complete adoption of the triple-expansion engine, and indicates the probable introduction, later, of the quadruple; while the cut-off in the high-pressure cylinder is set, for best effect, to give a terminal pressure in the low-pressure cylinder of not far from eight pounds per square inch. Under such circumstances, the gain by increasing pressures with properly constructed and proportioned machinery is known to be nearly proportional to the increasing values of the logarithms of the total, absolute, pressures employed.[3]

As the writer has elsewhere remarked:[4]

"As pressures have risen throughout the century, the value of the best ratio of expansion has correspondingly increased, and in still higher ratio, and the best work is now done in the best of contemporary engines, as a rule, at a ratio measured by the quotient $p_1 / 8$, or a slightly higher value. The Milwaukee pumping engine, for example, gives $p_1 / 6.5 = 20$, nearly. From what has preceded it is seen that the efficiency, the quantity of work which may be obtained from the unit-weight of steam, may be at least approximately taken as proportional to the logarithm of the ratio of expansion for maximum efficiency, and that consequently the cost of power will be proportional to the quantity

$$W_1 = m / \log p_1,$$

where $W_1$ is the weight of steam per *I. H. P.* per hour, and $p$ pounds per square inch. The

[1] "Manual of the Steam-Engine;" Dr. R. H. Thurston; Edition of 1897, Chap. VIII.

[2] "High Steam-Pressures on Sea-Going Ships;" Part I; Dr. R. H. Thurston.

[3] *Trans.* A. S. M. E., 1896. "Promise and Potency of High-Pressure Steam;" Dr. R. H. Thurston.

[4] Ibidem.

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value of this constant, *m*, employing common logarithms, was fifteen years ago about 40, and is now probably not above 30 for good constructions; it has become, in the case of the best class of engines above referred to, about 25, including all wastes. Accepting the last measures as limiting figures for the higher pressures of steam which the engineer is coming now rapidly to contemplate and experimentally to investigate, we have approximately the following:

| | | | | | |
|---|---|---|---|---|---|
| Pressures..... | 100 | 200 | 300 | 500 | 1000 |
| Expansions..... | 15 | 30 | 45 | 75 | 150 |
| Steam used per *I. H. P.*..... | 13-15 | 11-12 | 10-11 | 9-10 | 8-9." |

Fig 3, page 9, in the May issue of Marine Engineering shows[5] the facts of history in respect to the progress made, in the better classes of steam engine, from the days of Savery and Smeaton to the present time, and also the basis of the improvement noted, as seen in the corresponding reduction of the internal wastes of the machine. In the earlier days of the steam engine these wastes were the main expenditure of the engine, constituting, sometimes, ninety or even ninety-five per cent of the total expenditure of steam. In our own times, the internal wastes of the engine, by "initial condensation," have been brought down to 20 or 25 per cent and the duty has been raised, partly by increase of pressure, but mainly by decrease of wastes, from about 3,000,000 to over 150,000,000, as measured by the customary methods of builders of steam pumping engines. Otherwise stated: The gain has reduced expenditures of fuel to about one-fiftieth the figures usual before the time of Watt, and a large fraction of this gain is due to improvements affecting reductions of extra-thermodynamic heat-wastes; the remainder has been principally due to rising pressures with provision for proportionally increased expansion.

The method of waste and its effect upon the working of the engine and its influence upon the magnitude of the most suitable ratio of expansion are best shown by a diagram, as in the accompanying Fig. 1, in which the ordinates represent the expenditures of heat or steam or fuel, and the abscissas measure the ratios of expansion at the stated pressure. This diagram, already elsewhere employed for this purpose,[6] is here reproduced as the best possible substitute for pages of text.

In Fig. 1 the lower curve of the diagram represents the variation of costs of power with variation of the ratio of expansion, with the best triple-expansion engines of our day, when employing steam at a pressure of about 150 pounds, absolute, and where, as in the purely thermodynamic case, only thermodynamic energy-transfers and transformations are occurring. At the limit, thirty expansions, the cost of power is about 9,000 *B. T. U.*, or in the neighborhood of eight and one-half pounds of steam per *I. H. P.* per hour. Friction adds a fifth to these figures, and internal wastes, in the case of the simple engine, reduce the ratio of expansion giving best effect to eight or ten, and the expenditure becomes nearly twenty-five pounds per *I. H. P.* per hour, or about 24,000 *B. T. U.* Compounding cuts the wastes in half, and these figures become $r = 10$; $W = 16$; $H = 17{,}500$. The triple-expansion engine drops the cost to 14,000 *B. T. U.*, or about thirteen pounds of steam, and the ratio of expansion becomes, at best effect, about fifteen, Finally, the quadruple-expansion engine gives, for the same pressure—which is, however, too low for its best working—12,000 *B. T. U.* and eleven pounds of steam per *I. H. P.* per hour, and raises the ratio of expansion for best effect to twenty, or more, in this particular case.

Next, adding the equivalent cost on investment account, the dotted lines show that, in the case of the stationary engine, at least as here taken, the highest financial returns are secured by still more moderate ratios of expansion, and the diagram indicates the results, measured as before. The costs of adaptation to the thermodynamic requirements, in order to make the "duty" of the machine a maximum, are such as to restrict the extent to which it will pay to seek economic gain, and to a much greater extent than is commonly realized by even the best designers and builders. In the cases here illustrated the maximum net financial return is secured when the simple engine is proportioned for a ratio of expansion of about five, the compound for ten, the triple-expansion for thirteen, and the quadruple for about sixteen. These figures are, of course, modified by every variation in costs of construction and of operation, as well as of fuel and supplies, and of wages. The point to be here brought out clearly, if possible, however, is simply that an engine, if properly adapted to business purposes, is designed, not to give maximum duty—minimum expenditure of steam and of fuel—but maximum financial returns, the largest possible economy in capital expended or employed to produce the demanded power, and that this last measure of a true economy may dictate a very different proportion of engine, and often a much less economy as measured in heat, steam and fuel consumed than that giving highest duty. Notwithstanding this fact, however, it is none the less important to ascertain what are the proportions which insure best thermodynamic effect, as well as the extent to which these conditions are affected by considerations of extra-thermodynamic expenditures and financial costs. Experience indicates that we may hope to make our work with high-pressure steam at least as nearly perfect as hitherto at low pressures, and, knowing the theoretical, purely thermodynamic performance of the steam engine under stated pressures, we may deduce with some degree of confidence a probable actual efficiency and the rate of gain to be anticipated with increasing pressures, far beyond past practice or experience.

[5] "High Steam-Pressures on Sea-Going Ships;" Part II.

[6] *Trans.* A. S. M. E., 1896; "Manual of the Steam-Engine;" Chap. VIII.

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Comparatively little is known of the actual working economy of steam engines at pressures exceeding 150 to 200 pounds per square inch; although some work has been done in the direction of making such pressures available, with a view to gain of economy in costs of power, both at sea and on shore. Taking the quantity of power obtainable from a stated weight of steam as varying with the logarithm of the pressure, and the wastes as reducible to a minimum and the same amount, proportionally, for all pressures, as the writer has elsewhere remarked, we are evidently not to expect a gain by simple increase of pressure from, say, 100 to 1,000 pounds, of more than about fifty per cent; the ratios of the logarithms of the two pressures presenting that relation.[1] Taking the best work of our time as averaging about 12,000 *B. T. U.* per *I. H. P.*, this gives promise of about 8,000 *B. T. U.* at the higher tension of steam; and these figures represent an efficiency approximating seventy per cent of that of the Carnot cycle at the same pressures. Perkins and Albans, employing, experimentally, a half century ago and more, pressures of from 800 to 1,500, perhaps in some cases 2,000 pounds per square inch, proved to their own satisfaction the practicability of handling such tensions safely and the "promise and potency" of maximum pressures, but their efficiencies of engine have been often and greatly exceeded by later builders with what are now common pressures, and the thermodynamic defects of their machines were so great as to make their work useless for our purposes to-day. The successors of Jacob Perkins, Messrs. A. M. Perkins & Sons, of London, in the steamer "Anthracite," secured an economy at 350 pounds pressure, and with a comparatively small engine, of 1.7 pounds of fuel, 1.6 pounds of combustible, 17.8 pounds of feed-water and 20,000 *B. T. U.*, per horse power per hour, with a triple-expansion engine; the "cylinder-condensation" being about 30 per cent in the high-pressure engine-cylinder.

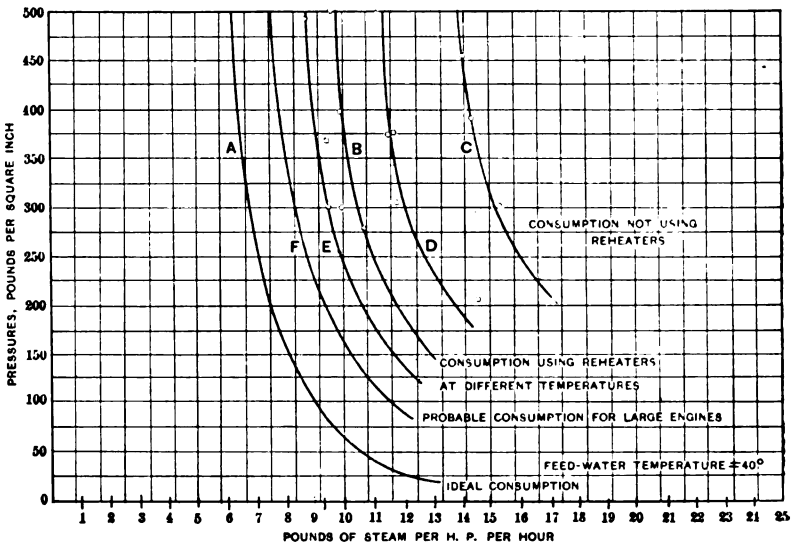


FIG. 1.—ENGINE EFFICIENCIES.

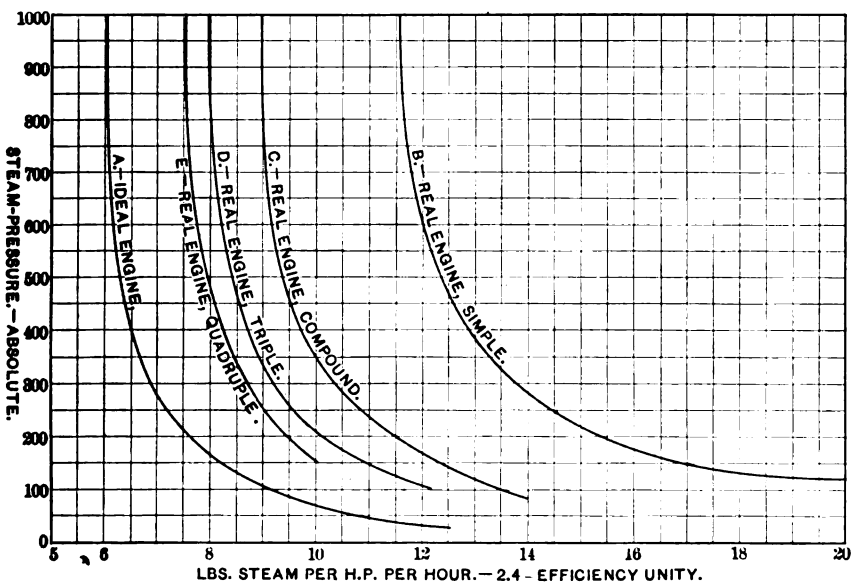


FIG. 2.—PROMISE OF HIGH PRESSURE STEAM.

The case about to be discussed is one in which 500 pounds pressure was provisionally adopted and the engine, a quadruple-expansion, was proportioned for that figure. Experience to date, however, shows, it would seem, that the machine, although performing remarkably well for so small an engine at the higher presssure, does its best work at more nearly 300 pounds. The promise of gain by increasing pressures is well known, for the case of the large engine, such as gives us to-day our "record-breaking" performances, in Fig. 5 of the articles already referred to, and as illustrated in the issue of this publication of May, 1897, page 11, and here reproduced as Fig. 2, and it shows that it should be practicable to secure as low an expenditure of heat as about 7,000 *B. T. U.*

[1] Ibidem.

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at 1,000 pounds, and 8,000 at 500, when the engine is so constructed as to reduce the extra-thermodynamic wastes to twenty-five per cent. of the ideal requirement. Such could not be the fact with a little engine, of but twenty horse-power, such as is to be described; in which the excessive proportion of cylinder-wall to enclosed steam makes certain a comparatively large amount of initial condensation. In the diagrams, Fig. 2, it is assumed that it will be practicable to secure as high efficiency of boiler at the higher pressures as at those now employed.

*The Ideal Case* is easily computed for any assumed pressure. Thus, for example, taking the initial pressure as 500 pounds per sq. in., the back-pressure in one case as 5 pounds, in another as 2, and the ratio of expansion as 64, in both cases, we have the following, adopting Rankine's methods of computation:[8]

DATA AND RESULTS.

$p_1 = 500$ lbs.; $p_2 = 6$ lbs.; $p_3 = 5$ lbs.; $r = 64$.

| | |
|---|---|
| Mean effective pressure | 31 lbs. |
| Efficiency of fluid | 0.2575 |
| B. T. U. per I. H. P. | 10.200 |
| Steam per I. H. P., per hour | 9.25 lbs. |
| Coal per I. H. P., per hour | 1.03 " |

Reducing the back pressure to 2 pounds per sq. in., these figures are improved to the extent of ten per cent, and we have:

| | |
|---|---|
| Efficiency of fluid | 0.28 |
| B. T. U. per I. H. P., per hour | 9.200 |
| Steam per I. H. P., per hour | 8.5 lbs. |
| Coal per I. H. P., per hour | 0.9 " |

It is here assumed that 1,100 *B. T. U.* are available per pound of steam with a good boiler and heater system, and that the area of heating surface is ample to insure an evaporation of nine pounds of water per pound of good fuel. For unity efficiency, this would give but 2.3 pounds of steam and 0.26 pounds of fuel per *I. H. P.* per hour.

Assuming the total wastes of heat to be measured by the percentage $w = a\sqrt{r}$, and the value of $a$ for an engine of considerable size to be, as found for large mill engines, about 0.15, we obtain the loss for the simple engine, $w = 0.15 \times 8 = 1.2$, and the total expenditure of feed-water per horse power per hour here becomes, for the two cases respectively, 20 and 18 pounds. Taking the wastes as inversely as the number of cylinders in series, within the limits here observed, we have the following for the computed and probable costs of power in the two cases:

EFFICIENCIES OF MULTIPLE-CYLINDER ENGINES.

| Form of engine | $p_3 = 5$. | $p_3 = 2$. | | | |
|---|---|---|---|---|---|
| Ideal case | 9.25 | 8.5 lbs. | steam per I.H.P. per hr. | | |
| Simple jacketed | 20 | 18 | " | " | " |
| Double expansion | 14.5 | 13.5 | " | " | " |
| Triple expansion | 13 | 11.5 | " | " | " |
| Quadruple expansion | 12 | 10.5 | " | " | " |

Were the same investigation made for steam-pressures approximating 1,000 pounds, the results would exhibit but ten per cent better figures. Compared with the now usual figure, 100 pounds per sq. in. of boiler pressure, the elevation of the pressure 400 per cent would give, as seen already, about 30 per cent gain, and increase to 1,000 per cent about 50 per cent gain. It is further obvious that a well-designed and efficient, yet not excessively expensive, engine could be adapted to the employment of these higher pressures, the gain in efficiency might, in many cases, handsomely repay the costs.

The above figures are at the present moment particularly interesting, in view of the steady rise of pressure, at sea, that we have observed in late years. The comparison of the two columns of the last table suggests, however, another and very important point: The reduction of the back-pressure from five pounds to two has as much effect in the decrease of costs of power as does increase of steam-pressure 50 per cent or more; as, for example, the rise from 100 to 150 or 160 pounds pressure. It is useless to raise the steam-pressure, and to accept all the attendant disadvantages of cost and risk, if the back-pressure cannot be kept down. Tight stuffing boxes and a good condensing system are more important than any ordinary excess of pressure above the normal of the time.

[8] "Hand-Book of Engine and Boiler Trials;" Dr. R. H. Thurston, p. 389. *Vide* the Writer's "Manual of the Steam-Engine;" Vol. I, p. 613, for such computations. Also in *Trans.* A. S. M. E., 1896, "Promise and Potency of High-Pressure Steam."

## AN ACCOUNT OF THE CONSTRUCTION AND PERFORMANCE OF A "CANOE LAUNCH."

We herewith illustrate a very handsome little motor boat, which the builder, J. H. Rushton, of Canton, N. Y., has called a "canoe launch." Its water lines are those of the "Vesper" sailing canoe, which is 16 ft. by 30 in. One foot has been added to the length, in a neat overhanging stern, and about 3 in. to the width, making the dimensions of the new boat 17 ft. by 32 in.

The keelson is of oak, 7-8 in. thick by 3 in. wide at the center of the boat, tapering to about 1 in. at the bow and stern. The planking is 3-8 in. thick of clear Michigan white cedar, except the sheer strake, which is of Spanish cedar. Red elm is used for the ribs. The deck timbers and inside floors are of white pine, while the deck is of fine figured mahogany 1-4 in. thick. Cherry is used for gunwales, fender rail, coaming and general finish. The boat is double-clinch, fastened with copper and brass, and is finished with best spar varnish throughout. The skin is smooth, the laps being nailed from each side, and all seams laid in spar varnish. The cockpit measures 10 ft. by 19 in., and is pointed with flaring coaming forward, as in a sailing canoe. Close in the bow is a copper air tank, and aft of that, under the forward deck, a gasoline tank of galvanized iron, with a capacity for eight gallons, is provided. On account of the propeller shaft, exhaust pipe and muffler, no air tank could be placed in the stern, and the space there is filled with cork blocks, thus making the boat non-sinkable. The lower rail or fender is grooved on the

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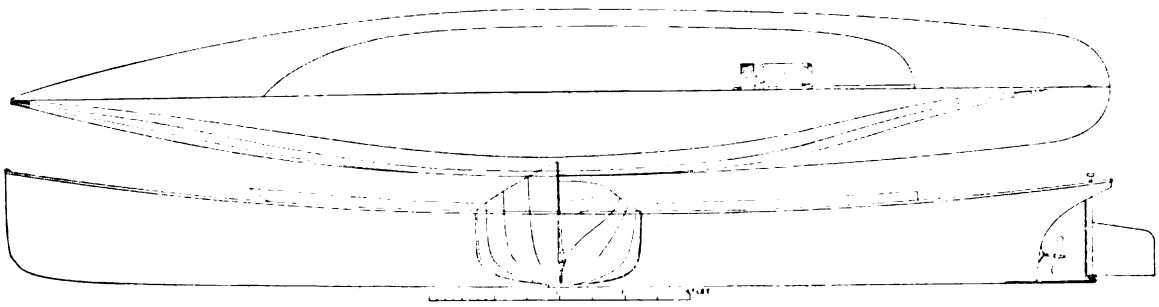
under side, giving a finger hold by which the boat can easily be carried by two men on each side. The propeller wheel is protected by a stout wrought-iron shoe, which is braced from the underside of the counter, and which also carries the foot of the rudder post. The propelling

With regard to the performance of the boat, Mr. Rushton gives this narrative of his recent experiences:

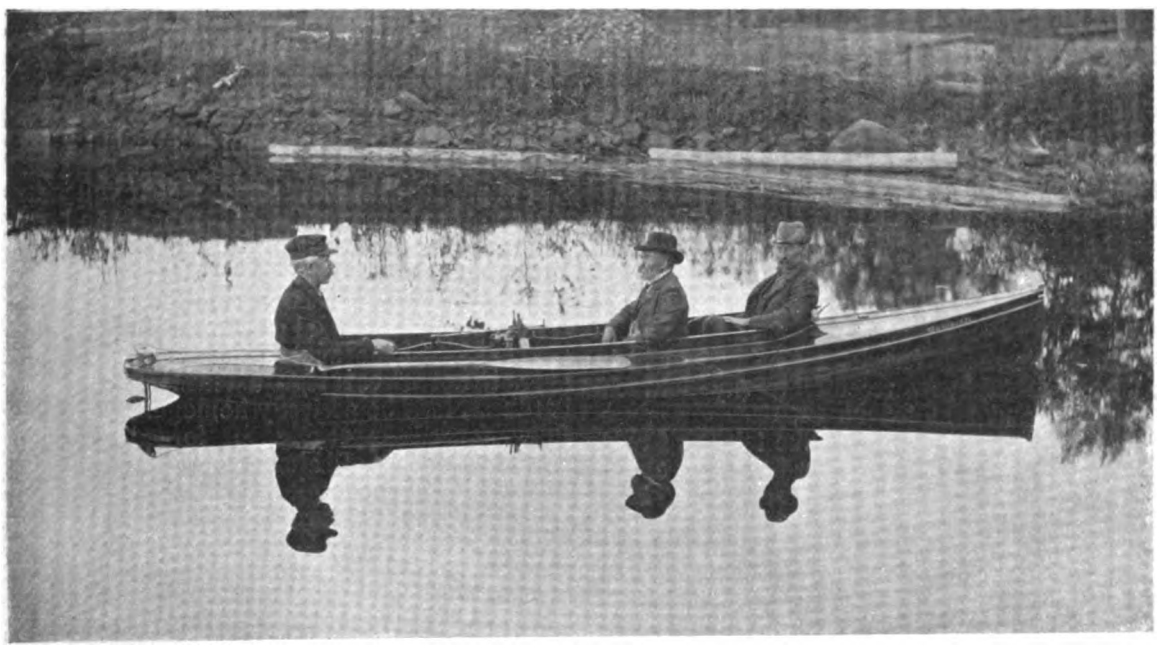
"The canoe launch was hauled to Ogdensburg from Canton, a distance of 18 miles, on an ordinary platform spring wagon, and put on board the



LINES OF A CANOE LAUNCH DESIGNED BY J. H. RUSHTON.

power is a Wolverine, Jr., gasoline motor, rated at 1 H. P., and fitted with a 12 in. two-blade reversing propeller wheel. The exhaust pipe passes aft along the bottom of the boat (inside), under the stern seat, and up to the deck, where it outlets through a nickel-plated mouthpiece on the deck, directly aft of the rudder post. The battery for supplying the electric igniter of the engine is a dry one, containing five cells, which are stowed in a pocket under the deck at one side. On the other side similar pockets hold tools, oil cans and other sundries. Almost any grade of gasoline

steamer Empire State. A friend was with me, and we had intended cruising up to the A. C. A. camp at Grindstone Island. We found the wind blowing directly down the river, almost a gale, and a big sea on, and concluded the dollar asked to carry the two boats (we also had a 15 ft. by 30 in. open Canadian canoe along) to Thousand Island Park, about 45 miles distant, would be money well spent. We were put off at the Park, and as it was then growing dark we remained until morning. Having no convenient place where we could house the boats—where we could feel that



PHOTOGRAPH OF CANOE LAUNCH WITH THREE PASSENGERS ABOARD.

can be used in the engine. The entire outfit weighs under 500 pounds, and is at its best trim with three persons aboard of, say, 500 pounds total weight, making 1,000 pounds in all.

they would be safe from the investigations of the inquisitive—we anchored them under the dock on the leeward side and slept in them. At dawn we pulled out for camp, where we ran the boat

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more or less during the week following, and then ran down to Ogdensburg.

"The run down from Alexandria Bay, about 40 miles by the route we took, was made in six hours with the canoe in tow. There was quite a sea running, and the canoe persisted in taking the opposite side of every big wave, and was constantly twisting the launch off its course. But for this drag we could easily have covered the distance in five hours. We consumed, including evaporation, less than 8 gallons of gasoline on our entire trip. We found our craft a remarkably good sea boat for its size, as was proven by our taking the swell of a large excursion steamer at close quarters, and that without taking a drop of water into the cockpit."

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The new transatlantic liner Kaiser Friedrich, building at Schichau's yard at Dantzig for the North German Lloyd Co., will, in many respects, be a departure from the practice which has hitherto been followed in the fastest vessels. Her general dimensions are 600 ft. length over all; 64 ft. beam and 41 ft. depth from the keel to the upper deck. Her gross tonnage is 12,000 tons, and when loaded to 28 ft. draught her displacement will be 17,000 tons. She has a double bottom throughout, and is divided into eighteen watertight compartments, so arranged that any three adjoining compartments could be filled without risk of disaster. The engines for the twin screws will together indicate 25,000 horse power. They are quadruple expansion, with cylinders 43.25 in., 64.25 in., 92.125 in. and two 93.25 in. The engines have five cylinders working on three cranks. They are placed amidships, and consequently there are fire rooms abaft the engine room as well as forward. Steam will be supplied by nine double ended boilers and one single ended boiler, at a working pressure of 225 lbs. per sq. in. Three funnels will be fitted and two pole masts. The boilers will be worked with Howden's system forced draft. As the builder has had a very extensive experience with high speed steamers, the Kaiser Friedrich should turn out to be a flier.

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The double screw ferryboat Chebucto, which was built at Glasgow recently to ply between Dartmouth and Halifax, N. S., does not seem to be a very good sea boat. She left the Clyde for Halifax August 15, and, after being out about 260 miles, returned, nearly a week later. The excuse given was that she had experienced such severe weather, and had labored and strained so much, that the crew insisted that the vessel return to port. The vessel is built in imitation of an American ferryboat, and is 140 ft. long, 50 ft. broad, and 13.7 ft. deep moulded. She has a screw propeller and rudder at each end driven by two pairs of compound surface condensing engines fitted on one bed plate. During her trial trip she attained a speed of 10 knots, her draught at the time being 9 ft. forward and aft.

## RESULTS OF AN INVESTIGATION INTO THE CAUSES OF TAIL SHAFT BREAKAGES.

A very thorough investigation into the causes of breakages of tail shafts has been undertaken by John Gravell for the British Committee of the Bureau Veritas. His report reads as follows:

With reference to the corrosion and rupture which so often occur in tail-end shafts, there appears to be considerable difference of opinion, both as to the cause of, and the best means of preventing these accidents, but all are agreed that one of the chief causes is the galvanic action which takes place when liners of brass or similar metal are fitted to work in lignum vitae bushes in the stern tube or stern bracket.

Among the causes to which the breakage of tail-end shafts is attributed by various engineers are these: (1) Defects in the structure or working of the material of which the shafts are made. (2) Defects of design and proportion. (3) Bending stresses set up by the shafting getting out of line through unequal wear of bearings, or yielding of the vessel under different conditions of loading. (4) Vibration in after part of vessel. (5) Hammering produced by the sea acting on the propeller, when the latter is overhung, if the after bearing has been allowed to wear too slack. (6) Corrosion near ends of brass liners. Any one of these acting alone, or in combination with some of the others, will tend to shorten the life of the shaft, and may so reduce its strength as to make it give way unexpectedly.

Defects in material.—In some cases of broken shafts examination by the microscope has shown a very irregular structure of the metal, this irregularity differing sometimes considerably in different parts of the shaft. This is specially liable to occur in shafts made from scrap. When a shaft is made from iron scrap it is very difficult to obtain this unmixed with steel scrap, which will naturally spoil the homogeneity of the metal, and cause weakness. When made from steel scrap, it is equally impossible to secure its being all of the same quality and tensile strength, so that a shaft forged of such material can in no way be homogeneous. Shafts made from ingot steel, however, if not of too high a tensile strength and hardness, may be perfectly homogeneous if carefully forged—especially if forged under a hydraulic press. Shafts have also been made of cast steel without forging, and have given great satisfaction both in locomotive and marine work.

Defective Design.—Sometimes shafts have been made too light to allow not only for the strains which may come upon them, but also for corrosion, and sudden changes in diameter are also sometimes made which prevent the equalization of stresses throughout the length of the shaft, and cause them to be localized, thus tending to weaken the shaft.

Bending Stresses.—When bearings wear unequally, or when, owing to the weakness of the

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vessel, it yields under different conditions of loading, the shafting gets out of line, bringing heavy stresses upon the shafting—stresses which constantly vary in direction as the shaft revolves—thus tending greatly to shorten its life and produce rupture.

Vibration.—When a vessel is lightly built, or when she has powerful machinery, there may be an amount of vibration in the after part which will tend to produce molecular changes in the metal and make the shaft brittle.

Hammering.—When propellers are overhung, as is nowadays generally the case, and when the after-bearing is allowed to wear very loose, not only are bending stresses set up, but the action of the waves on the propeller, especially in a rough sea, causes the shaft to knock about in the bearing with a hammering action, which is liable to upset the molecular condition of the metal and lead to rupture.

Corrosion.—The majority of vessels have their tail-end shafts fitted with brass or gun-metal liners, working in bushes lined with strips of lignum-vitæ, sea water being freely admitted to act as a lubricant. When this is the case a galvanic action is set up between the iron or steel of the shaft and the brass or gun-metal of the liners through the salt water, and the iron or steel is eaten away at the point where the two metals meet, a groove, sometimes very deep, being formed round the shaft, weakening it suddenly in one place and making it liable to break under any extra strain. In order to get as much light as possible on this subject I have obtained opinions from some of our surveyors, and Lewis Evans, engineer to the North of England Iron Steamship Insurance Association, has kindly sent me a report on the subject, together with some interesting photographs of broken shafts. The ideas expressed in his report are practically the same of those of our surveyors. Thos. Mudd, of Hartlepool, has also been kind enough to send a wooden model showing the method of applying his patent protective sleeve, and a portion cut from a shaft that had corroded badly at the forward end of after brass liner, after only eighteen months' use, together with a most interesting communication in which he strongly contends that the main cause of corrosion of tail shafts is due to galvanic action. There is, however, no unanimity in the proposals for avoiding corrosion and reducing the liability to rupture.

Amongst the suggestions for curing the defects found to exist may be given the following:

When there are brass liners working in lignum-vitæ. (1) To carry the brass liners the whole way within the stern tube, the joints being either brazed or soldered, or otherwise made watertight. But even with this expensive arrangement water has been known to get through the pores of the metal and corrode the shaft underneath, where such corrosion could not be seen, (2) D. B. Morison's patent, in which the ends of brass liners are made of ziz-zag form where it touches the shaft, so that the line of corrosion, instead of running round the shaft at one part of its length, should take a similar form to the brass liner, and thus be distributed over a greater length of the shaft. (3) To carefully lap the shaft between the liners with marline, well soaked either in Stockholm tar or red lead, covering with canvas and painting well over with red lead paint. This has been found efficient in proportion to the care with which the lapping is done, so as to secure a thick and unbroken coating of tar or red lead; but it has the disadvantage of being troublesome when the shaft has to be examined. (4) The method patented by Thos. Mudd, of Hartlepool, of protecting the shaft between the liners by a tube or sleeve of india rubber, made tight at the ends of the liners. This has proved very successful in many steamers. (5) Filling the space round the shaft, in the stern tube, with tallow, or a mixture of tallow, and either rape or mineral oil, means being provided for adding fresh grease to replace any that may work out, and so keep the space full. This has proved efficient when the tallow has been pure, and free from any trace of sulphuric acid used in its preparation, and when the space has been kept quite full and the shaft protected from contact with sea water. (6) To do away with the brass liners and lignum-vitæ bush, and to let the shaft work on long bushes of white metal. This has worked well when the white metal bushes have been long enough and well lubricated either by water or grease, and has been largely employed in torpedo boats and other small craft. (7) Cedervall's patent protective box, which is bolted to the forward face of the propeller boss, and contains a ring or gland (packed inside and out) pressed out by spiral springs, and running watertight against the after-end of the stern tube. The stern tube is filled with the best olive oil, and grooves are cut to let the oil get to the bearings and air to escape. The oil is prevented from getting out by the ring or gland, so that the consumption of oil is very small; and is made up by a pipe and cock on the watertight bulkhead at the forward end of stern tube. This has worked well on Swedish vessels.

Recommendations.—In view, therefore, of the above considerations, I would offer these suggestions: (a) That tail-end shafts should not be made of scrap either in iron or steel, but that they should be of ingot steel not exceeding thirty tons tensile strength, and that when forged it should preferably be under a hydraulic press, rather than under a steam hammer. Also that whether forged or cast they should be well annealed. (b) That when fitted with brass or gun-metal liners working in lignum-vitæ bushes, all parts of the shaft between and beyond the liners should be thoroughly protected from contact with sea water. (c) That when not fitted with liners as above, either some such arrangement as Cedervall's should be adopted, or if the shafts work in white metal bushes, these should be of ample length and well lubricated by either grease or water.

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# IMPROVED APPARATUS.

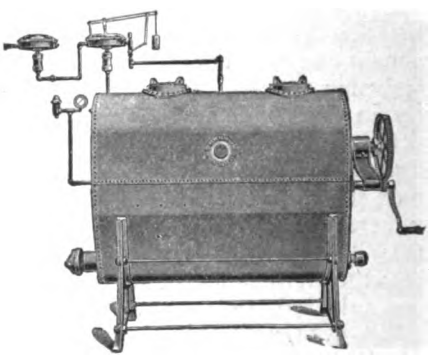
### Acetylene Gas Generator and Burner.

ACETYLENE GAS BURNER.

For the purpose of illumination aboard ship acetylene gas is attracting the serious attention of vessel owners. The compactness and cheapness of the generating plant, and the ease with which the manufacture of the gas can be carried on, or stopped, is likely to cause the substitution of acetylene gas for electricity in many cases. The lighting plant is entirely independent of the main or auxiliary machinery on board a vessel, and where electricity is not used for purposes other than illumination it is at a great disadvantage as compared with acetylene gas. The manufacture and use of this gas has, of course, only recently passed the experimental stage, but now forms of apparatus are obtainable which the trained staff of the engineers' department of a steamer can use with absolute safety. A convenient form of apparatus for using this gas is here illustrated. It consist of the "Naphey's" generator and the special burner which is necessary for the production of a smokeless flame. The generator is of the class known as "dry." It consists of a drum of sheet steel, within which is a receptacle for calcium carbide, from which the gas is produced, and a spraying apparatus for supplying the necessary proportion of water. There are two man-holes in the drum, one to supply the carbide and another to remove the waste. There are also three connecting pipes, one an inlet for water, another to give an exit for the gas, and a third as a drain when flushing or cleaning the tank. There is also a mechanism for turning over the carbide while the generator is in use. There are two valves attached to the generator, one to control the water supply, and the other the pressure of the gas. This pressure automatically controls the water supply so that the gas is manufactured as needed. Calcium carbide is a hard bluish-black crystalline substance, which is packed in convenient sized air-tight cannisters. In operation a charge of this carbide is placed in the generator, and the water is turned on slowly. An immediate generation of gas in quantity takes place. By having an excess of carbide and a minimum of water a dry gas is secured, and the operation of the machine is not affected by the rolling of the ship. The gas so generated is piped in the same manner as ordinary water gas, and burned in the special burner shown in the cut. This has two tips, from which gas is emitted and burned in a flat flame. When so burned the gas is intensely brilliant, producing a light which closely resembles daylight. For this reason a very much less quantity of gas is needed for each burner than would be the case with ordinary water gas. The proportions are, acetylene, 1-2 ft. per hour for 25 candle light, and ordinary gas 5 ft. per hour for 16 candle light. In the Naphey generator one pound of the calcium carbide of commerce gives an average of 4.48 cubic ft. of acetylene gas, or nine burner hours per pound of carbide. A generator with a capacity of 1,000 pounds of carbide occupies a space 3 ft. by 6 ft. This will operate 40 to 80 lights, and will give an illuminating value of about 80,000 cubic ft. of ordinary gas. The American agents for the apparatus described are J. B. Colt & Co., 117 Nassau street, New York, who will give any additional particulars needed for special cases.

### Surface Condenser and Pump Combined.

A surface condenser, combined on one base with air and circulating pumps, is here shown, as made by Dean Bros., of Indianapolis, Ind. The condenser is placed on top of the pumps, forming a self-contained apparatus. They are made in various sizes, from twenty horse power up. All air pumps are provided with sealed chambers to prevent air from leaking at the piston rod, and the valves are arranged so as to be at all times submerged with water. Instead of using cradle bars to connect the cylinders as shown, the cylinders are frequently placed on a bed. The surface condensers manufactured by this concern are made of selected material, with cylindrical shells, as that form combines lightness with strength. They are provided with necessary openings for exhaust steam and water connections; also, for hand holes for cleaning. All air and water pockets are carefully avoided. The tubes are of brass, specially made for the purpose, and are tinned inside and outside. The tube heads are of solid brass, with brass glands and cord packing of the style adapted by U. S. government engineers. Baffle plates are arranged for distributing the steam and protecting the



NAPHEY'S ACETYLENE GAS GENERATOR.

tubes at the opening. The steam is also diffused over the tubes by traverse plates. The tubes are

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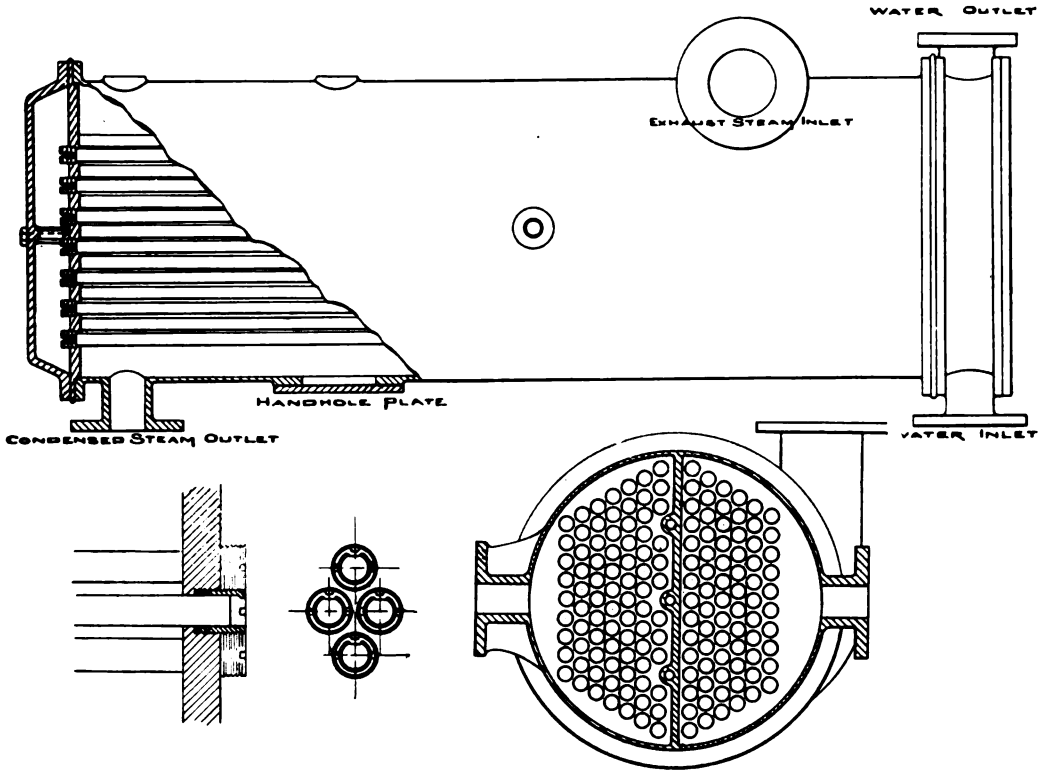
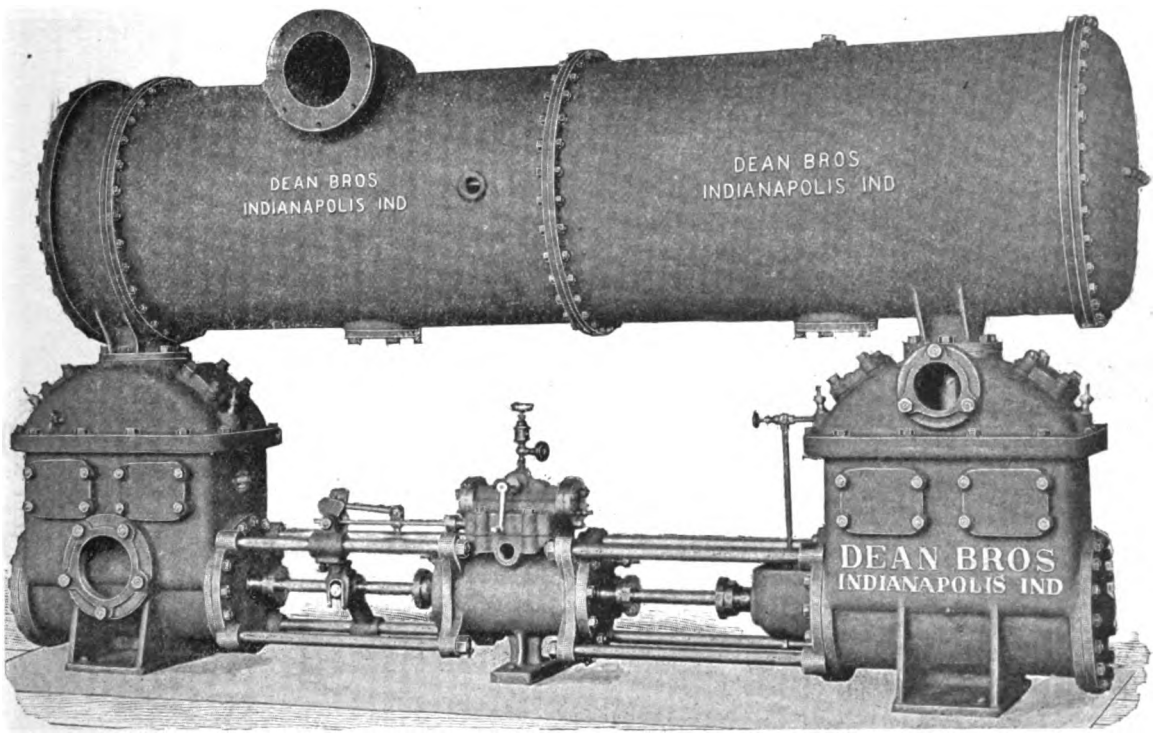
supported at their centers to prevent sagging, and stop lugs are provided to prevent the tubes from out of the heads. One and a half to two square feet of surface is required for each horse power,




SKETCHES SHOWING CONSTRUCTION OF DEAN SURFACE CONDENSER.




DEAN BROS.' COMBINED SURFACE CONDENSER AND PUMPS.

"creeping." Without such stops the tubes, by contraction and expansion, are liable to be drawn depending on the economy of the engine and temperature of the circulating water.

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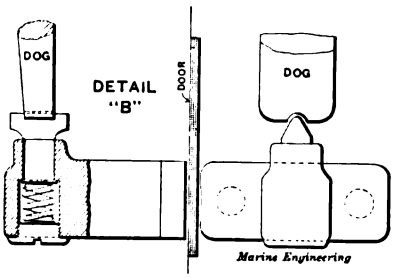
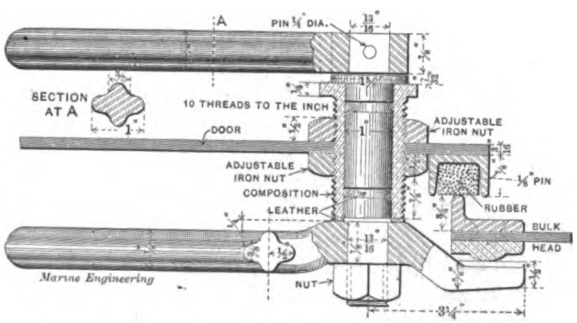
### Cross Adjustable Water-Tight Door.

A new adjustable water-tight door, the invention of Frank W. Cross, of Washington, is here illustrated. The design of the door is such



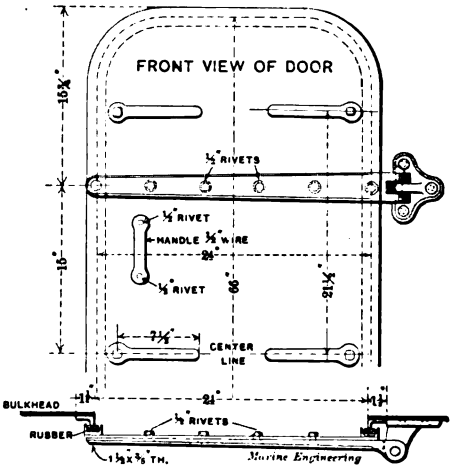

CROSS DOOR—DETAIL "B."

that no cutting or alteration of the frame is necessary in putting this door on ships that have the old style door. The clamping dogs are secured to the door, an advantage where a door comes in a passage where there is not room to put them on the bulkhead. A stop is fitted to hold the dog in position, so that there is no chance of a dog dropping down between the door and the frame and being bent or broken. The dogs and hinges are adjustable, allowing the door to be moved in or out so as to bring the angle iron in safe contact with the rubber packing. Wear of the rubber can thus be taken up readily by moving the jam nuts and turning the brass sleeve. This is much less troublesome than taking out the rubber and putting a liner behind it. The tension can be adjusted so nicely that the door will be water-tight without excessive pressure on the packing. It will be noticed that the groove for the rubber packing is the reverse of the usual style. In the old dovetail groove it is necessary to stretch the rubber to get in position, as the widest part of the dovetail is at the bottom of the groove. In the Cross door the rubber is readily slipped in place cut to exact length, and there is no tendency to contract and leave an open space between the ends. The levers on the door are of cast steel,

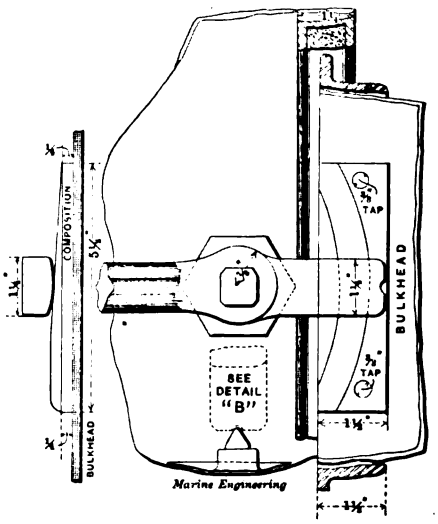



CROSS DOOR—SECTION SHOWING CLAMPS.

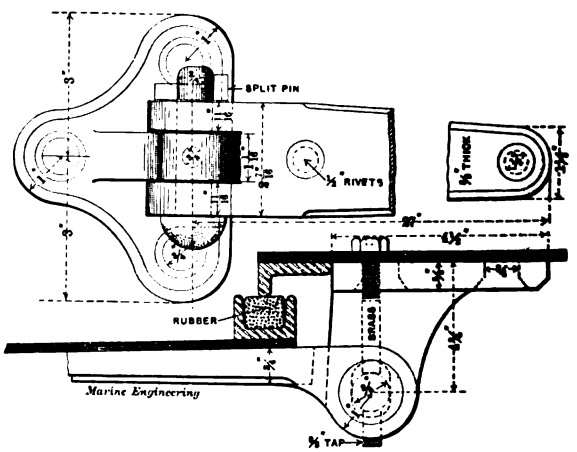
put on the spindle separately, and if broken or bent can be readily replaced. It is claimed for this door that it is a simple and practical construction, one that can easily be repaired on board ship, and that it is durable and inexpensive. It is manufactured by T. C. Basshor & Co., 28




CROSS DOOR IN POSITION.




CROSS DOOR—DETAIL OF CLAMP.




CROSS DOOR—DETAIL OF HINGE.

Light street, Baltimore, Md., who will be pleased to give any additional information desired.

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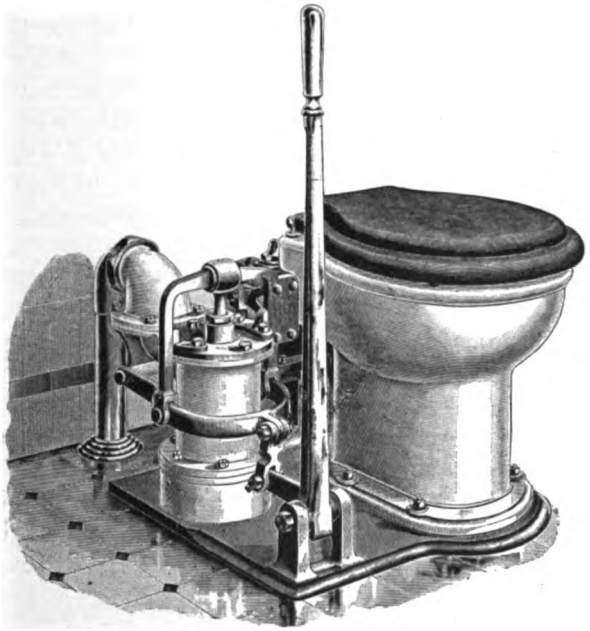
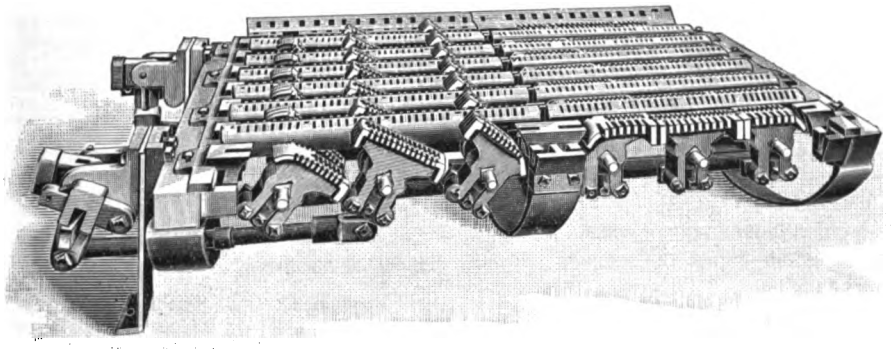
**Neptune Closet for War Vessels and Yachts.**

The Neptune closet, here illustrated, is designed especially for use in vessels in which the closet must be located either below the water line or at such a slight elevation that a pump is necessary to eject the contents. In this class are included war vessels and yachts. It consists of a galvanized iron base plate upon which is mounted a pedestal bowl of American vitreous porcelain, with hardwood seat and cover attached, and a brass supply pump and inlet valve and discharge pump, operated by a single lever. It is so arranged that the supply valve cannot be opened except by operating the lever, which also controls the discharge pump, so that an overflow is not possible. During the operation of pumping out the closet water is accumulated in a refill chamber, so that the bowl is constantly supplied with water. One great advantage of this closet is that one lever does all the work, and there are no foot treadles or hand pulls to be worked before water can enter the supply pump. It is the invention of Geo. B. Howells. The dimensions are: Length over all, 22 1-2 in.; depth from front of seat to back of discharge coupling, 30 in.; height from deck to top of seat, 17 in.; dia. of supply pipe, 1 1-4 in., and of discharge, 2 in. The closet is manufactured by McCambridge & Co., Ltd., 523-527 Cherry street, Philadelphia, Pa.



NEPTUNE MARINE PUMP WATER CLOSET.



REAGAN CHOPPING GRATE, SHOWING POSITION OF CHOPPERS IN USE AND AT REST.

**Reagan Dead Bar Chopping Grate.**

An improved form of grate which has been tried with much success under severe conditions of service, is here illustrated. It is named after the inventor, the Reagan Dead Bar Chopping Grate. The general arrangement of the grate can be seen in the accompanying engraving. The dead bars are made very strong, more than 1-2 in. thick at the top, which is pointed round with two rows of air holes opening into larger air cells below on either side of the rib center. This is 5-8 in. thick, and extends the length of the bar. The dead bars can be lifted out or dropped into place between the choppers with ease. They stand about 1-2 in. above the choppers and support the body of the fire. An air space is thus maintained between the choppers and the bottom of the fire, as the fire crusts and arches from bar to bar. As the grate is made in short sections with abundance of air passages there is little tendency to change of form and distortion, which is so troublesome in ordinary grates. It will be noticed that the choppers in the front and back halves of the grate can be operated independently or together, as required. Though the grate looks complicated, it has been found in practice to be really simple, and that it will work effectively under extreme conditions of forced draft. Its strongest point, perhaps, is that by its use the nominal and effective grate areas are identical, a condition which it is impossible to maintain with ordinary grates and heavy firing. It has been used successfully on many ocean vessels, including some of the fast ships of the American Line. The grate was invented by James Reagan, of the Water Circulating Grate Co. of Philadelphia. In New York and Philadelphia the sale is controlled by the James Reilly Repair and Supply Co., 230 West street, New York, and foot of Washington avenue, Philadelphia, Pa.

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# MARINE ENGINEERING

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The navy estimates for the fiscal year ending June 30, 1899, have been approved by Secretary Long and will be presented later to Congress. The total is $31,991,727.55, or $2,224,208.64 less than last year, for which the total was $34,215,936.19. This is a mere matter of totals, however, and not economies, for the building program only contemplates the construction of one vessel, a practice ship for the naval cadets. This cessation of building may be good politics, but it is poor policy if the nation desires to keep in the procession of naval progress. This is not simply because advances in material and construction are continuously being made by foreign powers, but because American builders have now had sufficient experience in the construction of war vessels to do quicker and better work than ever before. Every yard in which ships of the new navy have been built has learned much about construction which it did not previously know, and good as the first ships were it is certain that better ones could be built now; not stauncher vessels, but vessels in the building of which a thousand and one little modifications which practice has suggested could be used. Then, too, such yards have gathered together forces of trained men, who have become highly skilled in the exact kind of work demanded. These men unless continuously employed will drift away into other lines of work, and any practical manager knows that it is not easy to create such forces out of new material. The estimates include these items of special interest:

Construction and repair of vessels, $1,500,000; repairs to U. S. S. Hartford, $30,000; repairs to U. S. S. Chicago, $225,000; steam tug for Portsmouth, $50,000; improvement of construction plants at Portsmouth, $50,000 Boston, $50,000; New York, $50,000; League Island, $50,000; Norfolk, $50,000; Mare Island, $50,000; Puget Sound, $50,000. For completion repairs and preservation of machinery, $50,000; purchase, handling and preservation of all material, $400,000; improvements in engineering plants at Boston, $15,000; Norfolk, $25,000; Key West, $30,000; Port Orchard, $50,000; experiments with liquid fuel at New York, $5,000; experiments with fuel on two torpedo boats, $10,000.

Construction and machinery on account of hulls and outfits of vessels and steam machinery of vessels already authorized, $3,970,473; armor and armament, $4,254,800; increase Navy equipment, $175,000; for one composite vessel propelled by sail, $125,000

The last item, of $125,000, is presumably additional to the like amount already appropriated by Congress for the construction of this vessel, the original amount being inadequate.

Elsewhere in this issue a reference to the construction of an experimental tank at Cornell University will be found in a description of the uses of such a tank by W. F. Durand, principal of the School of Marine Construction at Sibley College. While this tank is a part of a general hydraulic laboratory installed in charge of the College of Civil Engineering, it is expected that, through the kindness of the director of the college, it will be available for distinctively marine work as well. With characteristic modesty Prof. Durand refers but briefly to the results which will undoubtedly follow the equipment of this station for experimental investigation of those problems which apply to safe and economical navigation of waters. In considering what has been accomplished by the use of similar apparatus abroad, and properly estimating the qualifications of those intrusted with the work of experimentation, the establishment of this tank is the most important undertaking in the history of American marine construction since Ericsson laid the keel of the Monitor. Contrasted with the progress made in other lines of scientific research—even in the abstruse field of astronomy—advancement in marine construction has been very slow in America. We refer particularly to steam propulsion. There has been much latent talent, which in certain lines opportunity has developed beyond competition. Witness the superiority of American designed sailing yachts. But, generally speaking, there have been few opportunities and fewer facilities. How many builders follow certain fixed rules or ideas, the only reason for which being that their ancestors did so, and like as not made money. Now, however, there is a prospect that American genius will have an opportunity to assert itself and in

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a purely scientific way. This is perhaps the most significant feature of the undertaking, for it is usually charged that progress here is induced by dollars and cents. With the Ithaca tank in operation America will enjoy the distinction of being the only country to possess such opportunities completely removed from all purely commercial or naval purposes. The good results which thus must follow are incalculable, for the results of investigation will not be read in secrecy and padlocked in security, but spread abroad among the profession. Every American builder will be a beneficiary, and it is a safe prophesy to make that the tank at Ithaca will influence not only the build of the noble liner, but even the unnamed barge which carries city garbage. It is a grand work for which the trustees of Cornell University have appropriated money, and it only remains to equip the station with apparatus commensurate with the needs of science and the capabilities of those intrusted with its charge.

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We are frequently asked if it is necessary for the owner of a motor boat, using other than steam power, to have an engineer's license or employ a licensed engineer. The law governing the operation of motor boats is of recent date, having been approved January 18 last. It is entitled "An act providing for certain requirements for vessels propelled by gas, fluid, naphtha, or electric motors." By its terms, all such vessels of "above fifteen tons burden, carrying freight or passengers for hire," are subject to the United States statutes relating to the inspection of hulls and machinery and requiring the employment of properly qualified engineers and pilots, and a strict compliance with the navigation laws. Consequently, the law does not apply to motor boats of small capacity used for pleasure only. Owners of such boats, however, who usually act as their own engineer and pilot, should, in justice to themselves, to those whom they may carry, and to the owners of all other craft, make themselves thoroughly familiar with the construction and safe operation of the apparatus used for propelling the boat. The many accidents which happen to such boats are usually due to carelessness or gross ignorance on the part of owners. They should also carefully study the rules of the road, and observe these strictly when running. Any disaster which might result from a breach of the rules would place the owner at a serious legal disadvantage in civil suit, not taking into consideration his moral responsibility.

The fifth general meeting of the Society of Naval Architects and Marine Engineers will be held in New York City during the present month. Through the courtesy of the executive officers of the American Society of Mechanical Engineers, the place of meeting will be in the building 12 West Thirty-first street, the well-known headquarters of engineering societies in New York. The proceedings will be opened by President Clement A. Griscom, Thursday, November 11, at 10 o'clock in the morning, and will continue during the day and on Friday, the day following. The meeting will terminate in a pleasant social gathering, which will take the form of a banquet at Delmonico's on Friday night, commencing at 7 o'clock. An interesting and diversified program has been provided through the efforts of the Secretary-Treasurer Francis T. Bowles. The papers cover a variety of timely topics, and are representative of the widespread marine interests of the country. The list of papers reads:

Thursday, November 11, 1897.

Watertight Bulkhead Doors. The "Long-Arm" System on the U. S. S. Chicago. By William Barnum Cowles, Esq., member.

Regulations for Loading Vessels. By Lewis Nixon, Esq., member.

Torpedo Boat Design. By Assistant Naval Constructor H. G. Gilmor, U. S. Navy, associate.

The Commerce of the Great Lakes. By C. E. Wheeler, Esq., member.

Progressive Trials of the "Guardian." By Prof. C. H. Peabody, member.

An Experimental Study of the Influence of Surface upon the Performance of Screw Propellers. Preliminary Paper. By Prof. W. F. Durand, member.

Friday, November 12, 1897.

Some Notes on the Speed Trials and Experience in Commission of our New Battleships. By Chief Constructor Philip Hichborn, U. S. Navy, vice-president.

Performance of Scotch Boilers and their Durability Under Forced Draft. By Edwin S. Cramp, Esq., member.

Use of Water-Ballast for Colliers in the Pacific Coast Trade. By William P. Frear, Esq., member.

Estimated Weights of Machinery. By Prof. George R. McDermott, member.

Navy Yard Expenses. By Naval Constructor W. J. Baxter, U. S. Navy, member.

Pneumatic Steering Gear, as Applied to the U. S. Monitor Terror. By H. A. Spiller, Esq., member.

Other business to be transacted at the meeting will include the election of officers, disposition of applications for membership, and probably the drafting of a set of resolutions expressing appreciation of the splendid reception accorded the delegates to the recent International Congress of Naval Architects and Marine Engineers in London. Secretary George Holmes, of the Institution of Naval Architects, recently sent to Walter M. McFarland, U. S. N., a very courteous reply to the joint letter of the American visitors, written before their departure from London. As a supplement to this issue we present our readers with a group of portraits of members of the society, representing the science and art of American shipbuilding and marine engineering in various sections of the country.

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# CORRESPONDENCE.

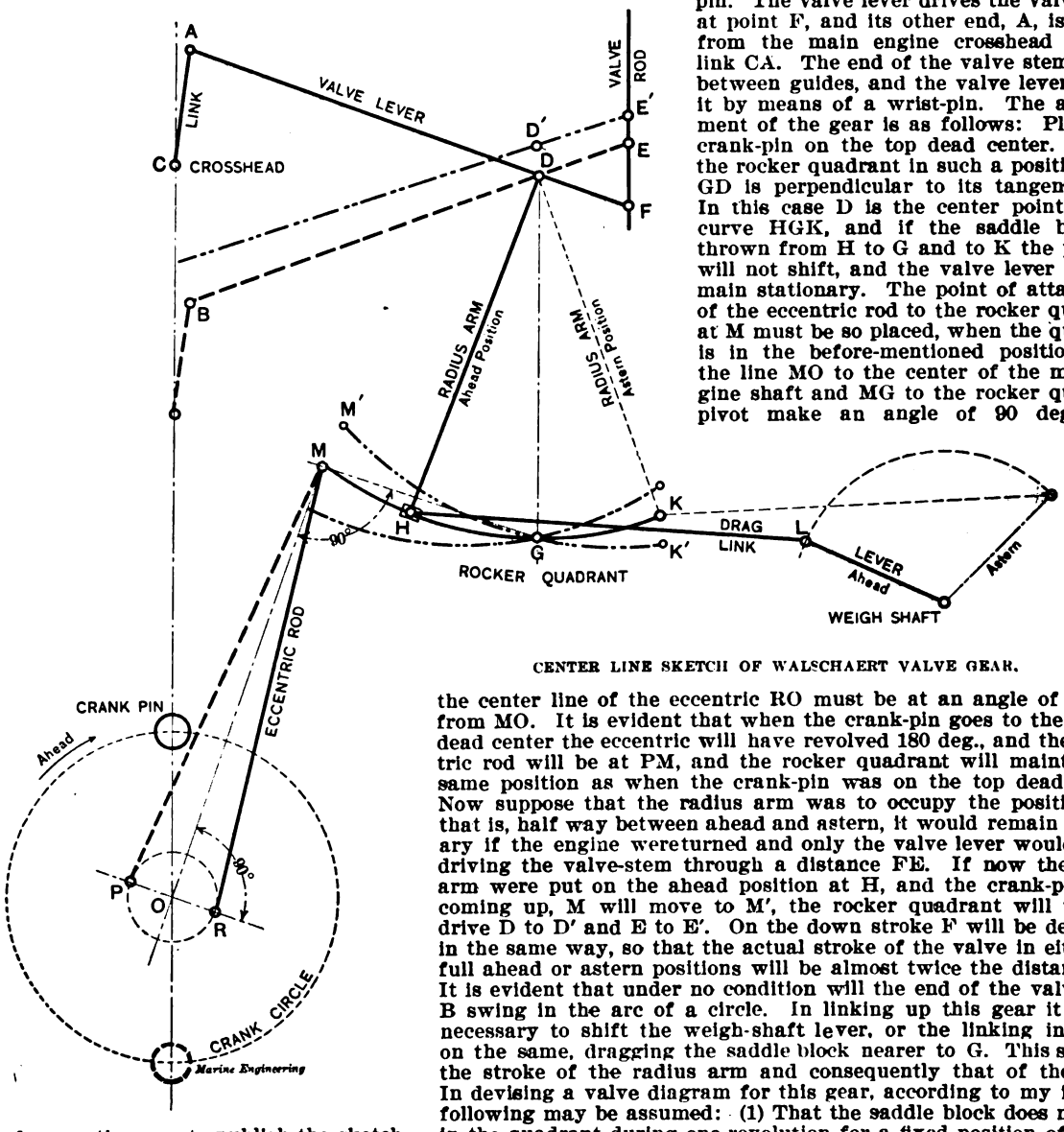
*[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.*

*Full names and addresses should be given, but publication of these will be withheld where requested.*

*We do not assume responsibility for the opinions expressed by correspondents.]*

### Walschaert Valve Diagram Wanted.

I herewith enclose a center line sketch of the Walschaert valve gear as used in marine work. I have been given to understand that this gear is also used in locomotive practice in certain countries in Europe. I have been unable to find any literature dealing with this gear, and as I am anxious to know what the valve diagram looks like, I take the liberty of requesting you to publish the sketch with the hope that some of your subscribers may be able to give the information required, or devise a diagram. The main characteristic of this gear is that only one eccentric is required to go either ahead or astern, and that the valve is placed at the back or front of the cylinder, thus saving space between the different cylinders of an engine, allowing the eccentric to be put close to the crank-cheek. The explanation of this gear may be easily understood by referring to the sketch. A single eccentric and rod oscillates a rocker quadrant which is pivoted at point G. This rocker quadrant has a saddle block sliding in it, and this saddle block can be drawn from one end of the quadrant to the other by means of a drag-link from the weigh-shaft lever, thus putting it in either the ahead or astern position. This saddle block has a radius arm, HD, connected to it by means of a wrist-pin, compelling the bottom end of the radius arm to move with it into the ahead or astern position. The radius of the curve of the rocker quadrant is equal to the length of the radius arm. The radius arm is also connected with a valve lever at point D by a wrist-pin. The valve lever drives the valve stem at point F, and its other end, A, is driven from the main engine crosshead by the link CA. The end of the valve stem works between guides, and the valve lever drives it by means of a wrist-pin. The arrangement of the gear is as follows: Place the crank-pin on the top dead center. Swing the rocker quadrant in such a position that GD is perpendicular to its tangent at G. In this case D is the center point of the curve HGK, and if the saddle block is thrown from H to G and to K the point D will not shift, and the valve lever will remain stationary. The point of attachment of the eccentric rod to the rocker quadrant at M must be so placed, when the quadrant is in the before-mentioned position, that the line MO to the center of the main engine shaft and MG to the rocker quadrant pivot make an angle of 90 deg., also




CENTER LINE SKETCH OF WALSCHAERT VALVE GEAR.

the center line of the eccentric RO must be at an angle of 90 deg. from MO. It is evident that when the crank-pin goes to the bottom dead center the eccentric will have revolved 180 deg., and the eccentric rod will be at PM, and the rocker quadrant will maintain the same position as when the crank-pin was on the top dead center. Now suppose that the radius arm was to occupy the position GD, that is, half way between ahead and astern, it would remain stationary if the engine were turned and only the valve lever would move, driving the valve-stem through a distance FE. If now the radius arm were put on the ahead position at H, and the crank-pin were coming up, M will move to M', the rocker quadrant will tilt and drive D to D' and E to E'. On the down stroke F will be depressed in the same way, so that the actual stroke of the valve in either the full ahead or astern positions will be almost twice the distance EF. It is evident that under no condition will the end of the valve lever B swing in the arc of a circle. In linking up this gear it is only necessary to shift the weigh-shaft lever, or the linking in gadget on the same, dragging the saddle block nearer to G. This shortens the stroke of the radius arm and consequently that of the valve. In devising a valve diagram for this gear, according to my idea the following may be assumed: (1) That the saddle block does not slide in the quadrant during one revolution for a fixed position of cut-off. (2) That the eccentric rod is of infinite length, hence its angularity may be neglected. (3) That the radius arm is of infinite length, so that its whole motion may be supposed to be vertical. (4) That the crosshead link is of infinite length, and also that equal divisions of the stroke AB will be proportional between points E and F

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when the radius arm is at GD. The angularity of the connecting rod, however, must be taken into account, as in marine work the connecting rods are only slightly longer than twice the stroke. In actual practice a line drawn through point D parallel with the valve rod would intersect the rocker quadrant at a point about half way between H and G. This helps to reduce the angularity of the radius arm when the engine is going ahead. From the above description it can be seen that the principal features of this gear are that the leads top and bottom are constant for any position of cut-off, also that it gives a long steam opening and a quick cut-off. In altering the setting of a valve within certain limits on an engine fitted with the Stephenson link motion, it is a simple matter to shift the eccentrics and alter the laps on the valve, but with this gear it would seem that any alteration would entail considerably more work. The eccentric could be shifted, but the leads top and bottom would then not be constant. The throw of the eccentric could be altered by making a new sheave, but this would entail moving point D on the valve lever, so that the valve would have the same stroke as before. In addition, the shifting of point D would put it out of position in reference to the rocker quadrant. If the valve alone were to be altered, for instance, the steam lap were reduced to get a longer cut-off, an excessive lead would be the result. Whatever advantages this gear possesses over the Stephenson link motion, it would seem that it is not as flexible as the latter when alterations are concerned. H.

# MISHAPS AT SEA.

### Collision Between Newport News and Columbia.

While the passenger steamer Newport News of the Norfolk-Washington line was on a trip to Washington early on the morning of September 7, she ran into the side wheel ferryboat Columbia, during a dense fog. The ferry was on the way to Alexandria, Va., at the time, and when nearly opposite that port she stopped, and the Newport News, which was coming along full speed, struck her almost amidships. Fortunately the blow was delivered at the paddle box and the energy of the ramming vessel was exhausted in crushing the wheel and smashing up the machinery generally. As will be seen in the engraving the steel hull of the Columbia was not damaged, and she was subsequently towed to Baltimore to the yard of James Clark Co., where repairs were made. Both vessels are comparatively new. The Newport News is one of the finest passenger vessels of her type in the country. She was built at the Newport News yard in 1895, and her dimensions are, length 260 ft., beam 46 ft. and depth 14 ft. Her hull is of steel, and she is fitted with quadruple expansion engines which indicate 2,500 horse power. The ferryboat Columbia is a composite vessel, built in 1891 by William E. Woodall & Co., Baltimore. Her dimensions are: length 148 ft., beam 48 ft. and depth 12 ft. Her machinery consists of a beam engine with cylinder 38 in. by 108 in., and one Scotch boiler supplying

FERRYBOAT COLUMBIA AFTER BEING RAMMED BY THE PASSENGER STEAMER NEWPORT NEWS.

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steam at 50 lb. per sq. in. The machinery was built and erected by James Clark Co. When she returned to their yard after the collision a survey showed that the damage to machinery consisted of a crushed wheel, bent wheel shaft, both cranks bent and lower end of connecting rod also, one leg of gallows frame broken, main pedestal broken, eccentric cam, eccentric strap and rods sprung, crank pin bent and crank pin brasses broken, all holding down bolts broken, and entire engine moved from its original position. This caused the removal of all the machinery and the substitution of a large amount of new work for parts damaged beyond repair. The wheel was so badly crushed that very little of it was used in the construction of a new wheel. The Columbia reached the Clark yard September 9, and left October 23 under her own steam for Washington, the repaired machinery working very smoothly during the trip.

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A novel method for preventing interference with their nonunion workers has been adopted by the Messrs. Yarrow & Co., the torpedo boat builders on the Thames. The shop has been endeavoring to keep going at full capacity since the great strike commenced. As part of the plan the passenger side-wheel steamer Southampton, which formerly ran in connection with an English railroad line in the Channel service, was moored out in the stream and here the men who replaced the strikers are berthed and have their meals. They are ferried to and fro in boats and steam launches. A regular routine was adopted, and the arrangements on the ship placed in charge of a special manager who has provided a number of social features for the entertainment of the workmen. The program includes entertainments of various sorts, and church service on Sundays. In the evenings after work a steam launch conveys them to whatever point on the river they want to go and returns for them again at a certain hour, all having to be aboard by 9.30 o'clock at night. The bell to turn out on weekdays rings at 5.20 o'clock in the morning and hot coffee is served, and shortly before 6 o'clock the men are conveyed ashore. They knock off in time to take breakfast at 8.30 o'clock, dinner at 1 o'clock, and tea at 5 o'clock. The ship's company includes a librarian, pianist, and a doctor, and so far the hundred men aboard this vessel have dwelt in peace and comfort.

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The annual report of the American Seaman's Friend Society, just published, recalls attention to the great usefulness of this organization. Reports from the various foreign ports where there are missions aided by the society all tell of great usefulness and missionary zeal with expressions of appreciation from seamen. In the home field, too, the reports show earnest work. The loan library of the society, for example, sent out 295 loan libraries during the year ending March 31, 1897, in which the volumes numbered in all, 12,685. The books have been read with real interest, judging from the expressions of those who enjoyed this feature of the work. Of the regular publications of the society thousands of copies were circulated. The report shows a sound financial condition, a small balance being carried over to the credit of the present fiscal year. The cash receipts from legacies amounted, during the year ending March 31, to $20,673.94, and from other sources of income to $16,608.65 additional, and the disbursements amounted to $31,001.55. The officers of the society are: James Elwell, president; C. A. Stoddard, D.D., vice-president; W. C. Stitt, D.D., secretary, and W. C. Sturges, treasurer. The headquarters of the society are at 76 Wall street, New York. It is supported by membership fees, voluntary contributions and by bequests made by charitably disposed persons and gives aid to chaplains at sixteen foreign and nineteen domestic ports.

# EDUCATIONAL.

## THE ART OF MAKING MECHANICAL SKETCHES, FOR MARINE ENGINEERS.*—II.

BY PROF. C. W. MAC CORD.

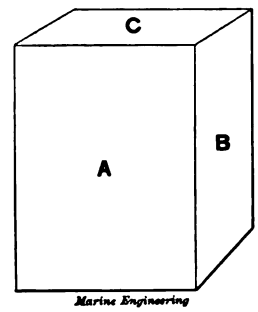


FIG. 1.

It is hoped that the following brief explanations may be of service to such of our readers as are not already familiar with the principles of making "working drawings," as distinguished from pictorial representations.

For illustration: A simple block of wood, such as is shown in Fig. 1, will answer. Three sides are visible, and it is clear that this represents the block as seen from a point not directly in front, but also above and to the right of it. It conveys a perfectly clear idea of the form, which is that of a rectangular prism, and a general idea of the proportions. But as neither the angles nor the edges appear of their true forms or sizes, no measurements could be taken from it, and it would be of no use to a workman if he were required to make a block precisely like the original. This drawing is said to be in *perspective* (which means seen through); since it might be made by looking at the block through a pane of glass, and tracing the edges thereon in their apparent positions, each corner being represented by the point in which a right line from it to the eye would pierce the glass—because light travels in straight lines.

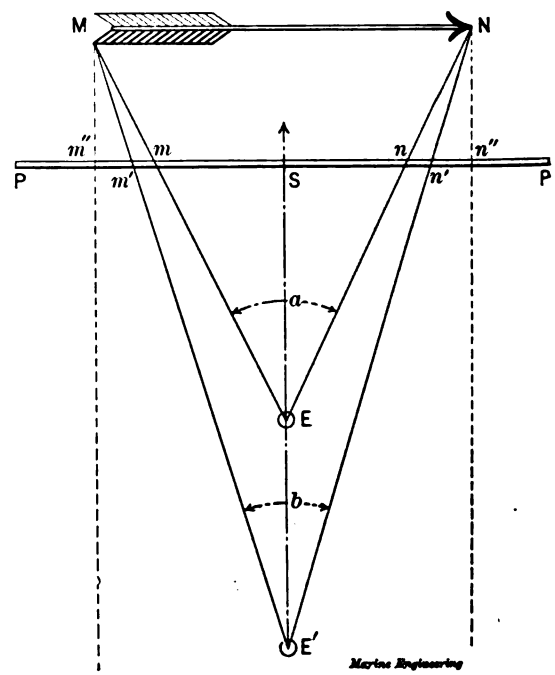


FIG. 2.

Now in Fig. 2, let P P represent the edge of a vertical pane of glass, seen from above; suppose the eye to be placed at E in front of it, and to be looking perpendicularly toward it, in the direction E S; and let M N, parallel to P P, be an object behind the glass.

* Commenced in July issue.

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In this case the rays of light M E, N E (or extreme *visual rays*) include a certain angle *a*; they pierce the glass at *m* and *n*, and *m n* is the apparent length of M N. But if the eye be removed to E', the extreme visual rays will include a smaller angle *b*, and the apparent length of the object will be *m' n'*, which is greater than *m n*. We see then that the farther back the eye is placed, the more nearly parallel the rays will be; if then we suppose the eye to be removed to an infinite distance, those rays will be actually parallel to each other and to the central ray S E. They will then be perpendicular to the glass, and the apparent length *m'' n''* will be equal to the actual length M N. This equality exists, however, only because M N is parallel to P P; in Fig. 3 it is not so, and since in any case the visual rays become perpendicular to P P when the eye is infinitely remote, the apparent length *m'' n''* is less than the real length, or, as it is technically called, is *foreshortened*. But these two figures show that on this supposition as to the position of the eye, the representation of any point is found by drawing a perpendicular through the point to the plane on which the drawing is made; and this is the distinguishing characteristic of the system of *orthographic projections*, used in making working

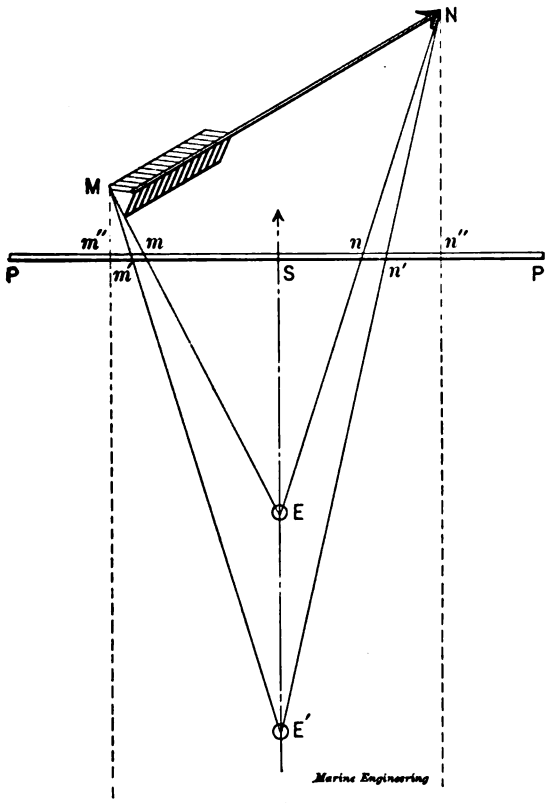


FIG. 3.

drawings. The arrow M N was selected for illustration, since, being long and thin, it can easily be imagined to represent an edge of the block shown in Fig. 1.

Now, suppose that object to be placed in a rectangular glass box, like a show-case with flat sides, the faces of the block being parallel to those of the box. Then standing in front of it, let each visible edge be drawn on the glass, just as M N is represented by *m n* in Fig. 2; from what precedes it should be clear that the result will be simply a rectangle of the same dimensions as those of the nearer face A. If we then go around and look perpendicularly against the right-hand side of our show-case, we shall in like manner produce a view of the face B, and if we suppose the eye to look vertically downward, we shall have on the top of the show-case a representation of the upper face C; and these will also be rectangles, of the same dimensions as those of the two faces themselves.

Now, suppose the top and the right-hand side of the show-case to be hinged to the front side by their nearer edges; then if the former be swung upward and the latter outward, they may both be made to

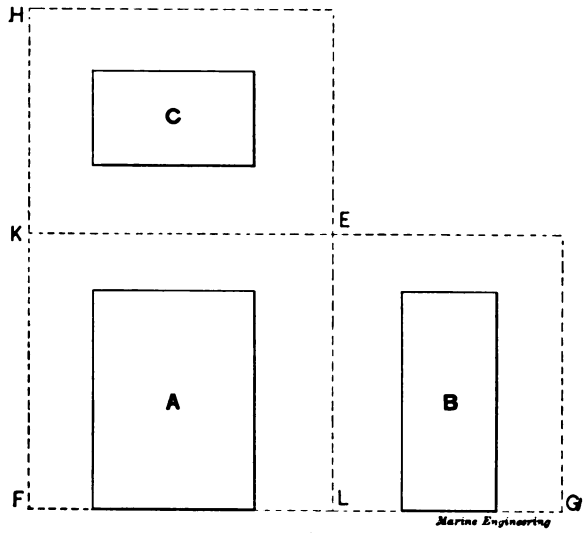


FIG. 4.

coincide with the plane of the front face. The three views above described will then be arranged as shown in Fig. 4, in which the three faces of the show-case are represented by the dotted rectangles, E H being the top, E G the right-hand face and E F the front; E K and E L are the hinged edges.

Each of these views, then, represents a different face of the prism, in its true form and size—which has given rise to the expression that these projections

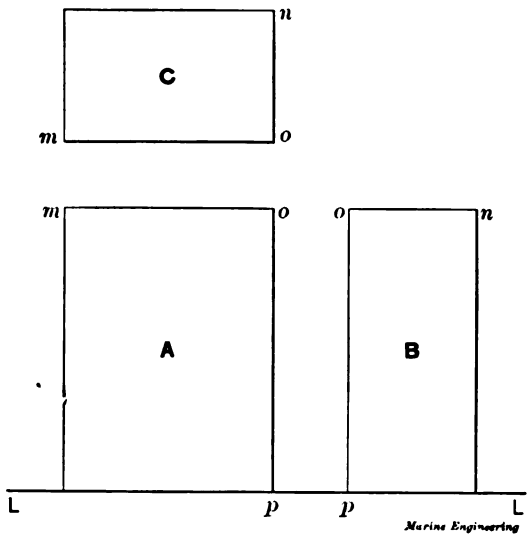


FIG. 5.

show an object as it is, while a perspective drawing shows it as it seems. Whether this is strictly true or not, it is certain that Fig. 4 conveys the information which will enable a workman to reproduce the original block, while Fig. 1 as certainly does not.

But the dotted lines in Fig. 4 are evidently not essential in representing the object; the imaginary show-case, which was introduced merely as an aid in the logical deduction of the method and the arrange-

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ment of the different views, may now be dispensed with, and the drawing of our prism made as in Fig. 5: we have here made use of a *base line*, L L, representing a horizontal plane upon which the object may be supposed to rest—which, though not absolutely

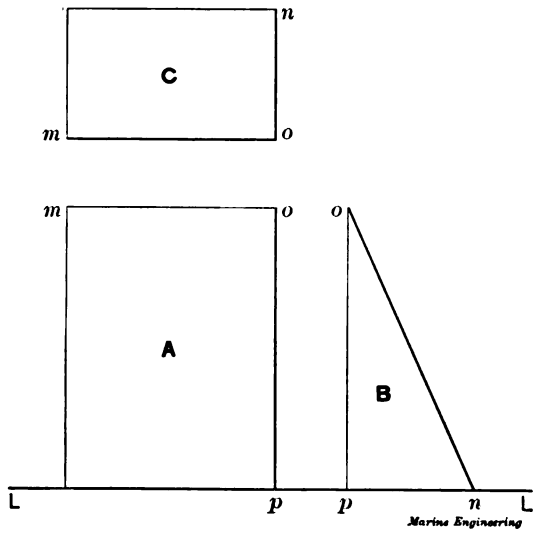


FIG. 6.

necessary, is in many cases very useful as indicating the position of the object.

Studying these views, we observe three things, viz.:

I.—Each shows two dimensions only: thus
A gives the length and the breadth.
B " " length " " thickness.
C " " breadth " " thickness.

II.—Consequently, one dimension is the same in any two views: thus
The length, *o p*, is the same in A and B;
" breadth, *o m*, " " " " A " C;
" thickness, *o n*, " " " " B " C.

III.—Considering A as the front view, it is noted that the view B, which shows the same object as seen from the right, is placed at the right of A. Had it been desired to make a view as seen from the left, that view would have been placed at the left of A.

And these observations hold good in all cases, whether the object be a simple one like that chosen for illustration, or one of the most complex nature.

The mere fact that each view gives only two dimensions leads at once to the deduction that in general at least three views are necessary to define the object perfectly; and sometimes several more are required. There are cases, of course, in which two will suffice, as, for example, a simple circular cylinder would require only an end view and a side view. But Fig. 6, in which the views A and C are the same as in Fig. 5, will suffice to show that even in very simple cases no less than three may be necessary. It is in the nature of things impossible to lay down a rule by which to determine either what views or how many of them should be made; but there is one axiom which the beginner should fix in his mind at the start, and keep it there to the finish: and that is, that the drawings must be such that by their aid the workman can make what is wanted, and cannot make anything else.

The position of the block chosen as the object to be drawn, in what precedes, is that in which its lines and faces are parallel to the paper in each view; this is clearly the most simple position in which it can be placed, and it is necessary to possess the information conveyed by Fig. 5, in order to proceed intelligently in representing even so simple a thing as this is, in oblique positions, where the lines and angles do not appear in their true forms and sizes, which is sometimes necessary. But it is to be noted that in a working drawing the most simple position should always be selected; and, without waiting for any explanation of more complicated matters, what has previously been explained can be put to very good and practical use in representing minor mechanical details.

In illustration of this, we give in Fig. 7 two views of a small cylinder, with a round flange at one end, and at the other a square one through which are drilled four bolt-holes. When in place, this piece may have had a vertical or an inclined position, but in making a detached sketch of it the drawing will be of more convenient form if the cylinder be laid on its side. In this case two views are sufficient, since a top view, if made, would be exactly the same as the side view. Since the large square flange happens to be at the right, we make an end view from the left, because then the circular flange will not obscure the other; in this view, in fact, the only thing hidden is the outline *m* of the exterior surface of the cylinder, which is indicated in dotted lines; as also is *n*, the interior outline in the side view.

This object is symmetrical about an axis, which is indicated by a fine continuous center line *h h*, drawn through and beyond both views; and short center lines are drawn to represent the axes of the bolt-holes, as at *k k*.

In the end view, a vertical center line, *v v*, is drawn through the center of the cylinder, and the centers of the bolt-holes are likewise located by short cross center lines. Since these lines are imaginary, they ought never to terminate in a boundary line, and they should be made as fine as possible consistently with distinctness.

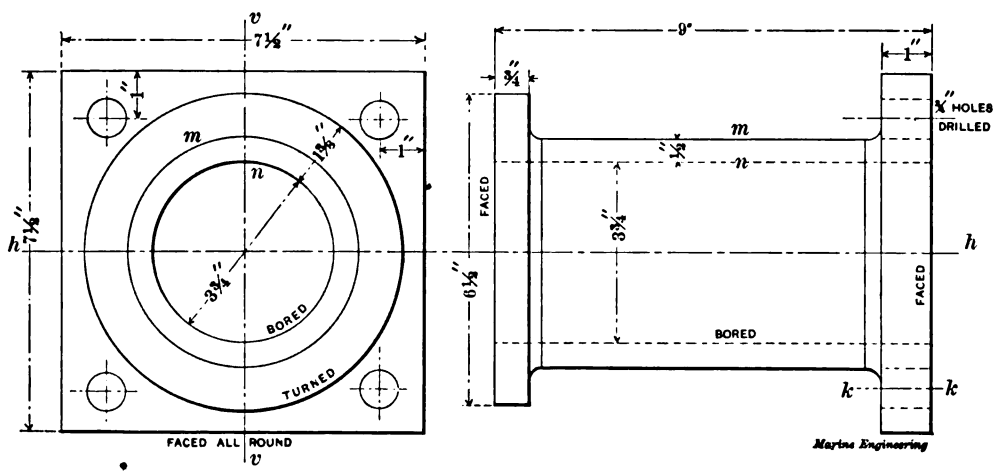


FIG. 7.

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These center lines are of the greatest importance in making a finished drawing, being, in fact, always drawn before the circles are struck; but even in a sketch they should always be put in, as a guide to the draughtsman or the machinist, as the case may be.

The sketch must also be complete in respect to the dimensions, as well as in regard to instructions for facing, turning, boring, drilling and the like. And in making a sketch, as well as a finished drawing, the measurements should always be made from center lines or from finished surfaces when practicable, for a rough surface is never perfectly reliable.

Attention is called to the manner in which the figured dimensions are arranged in this example. In the first place, no figure is placed upon a center line; nor are any dimensions written close to the outlines. Had the diameter of the round flange been put in, as we have often seen it done, between the two lines showing its thickness, in the side view, the effect would have been confusing. Each figure should as far as practicable stand in an open space by itself, and be so placed as to be conspicuous and to catch the eye; moreover, each one should be boldly written and carefully formed, in order to avoid any possibility of mistakes in reading them; inattention to this may lead to serious consequences, as an error committed in metal is often an expensive matter.

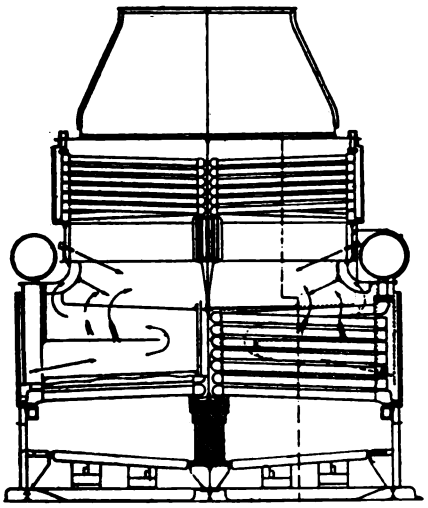
# SELECTED PATENTS.

*590,829.* STEAM GENERATOR. *Louis Marie Gabriel Delaunay-Belleville, Paris, France. Filed Sept. 24, 1896.*

In a steam generator the combination with economizer tubes E, located at the upper part of the generator, of generator tubes D, above the fire chamber, a mixing and combustion chamber F, between the economizer tubes and the generator tubes, vertical hot air pipes G having apertures g for the entrance of outside air, these pipes being near the front portions of the generator tubes, and means for forcing air from the exterior into the mixing and combustion chamber, under pressure, and for heating the air on its way to the combustion chamber.

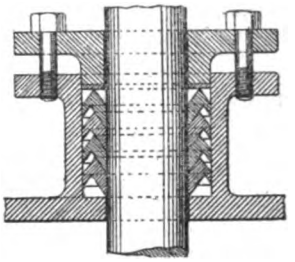
*591,670.* METALLIC PACKING. *William H. Law, Brooklyn, N. Y. Filed Apr. 22, 1897.*

A sectional packing, the sections of which are formed of split rings each like or a counterpart of



BELLEVILLE STEAM GENERATOR.

the other sections so as to be interchangeable throughout, each section having a channeled face and a ridge-face, the channels having their edges of unequal length and the channel and ridge of each section having their respective apexes out of alignment with one another, combined with a stuffing-box and a piston-rod or movable part, the packing sections being made to seat their sides against the



LAW METALLIC PACKING.

box and rod while having the ridges partly inserted into the channels.

## BOOK NOTICE.

Books of foreign travel are so numerous and so frequently mere repetitions that the busy business or professional man cannot profitably give time to their perusal. The exceptions are consequently the more valuable, and in this class comes the little work "American and Other Machinery Abroad" by Fred J. Miller, editor of the American Machinist. The sub-title tells the reader that the book is a study of the European field for the introduction of American machinery. It is a clever, clear account of what might be called the machinery conditions in all the foremost countries of Europe, written by an unprejudiced expert. The book is extremely opportune now that manufacturers are wakening up to the possibilities of foreign trade. Allowance will be made by any rational reader for the few discrepancies which appear in it, as the author was apparently on the move during the whole of his stay in Europe. It is specially valuable as representing the American view of the subject, not at long range, but after a careful reconnoissance of the field. Notes on American machinery abroad which appear in technical publications are usually written by foreigners living abroad who, of course, are unconsciously partial to their own country. There is only one serious mistake in the book: an "excuse" for the publication, made by the author. This was entirely unnecessary. Not a single machinery manufacturer in the country could give a valid excuse why he should not read it. The book is issued from the press of the American Machinist, 256 Broadway, New York. Price 50 cents.

The powerful additions to the Italian fleet were launched recently from Italian yards. One was the armored cruiser Garibaldi, and the other the battleship Emmanuele Filiberto. The Garibaldi is 326 ft. long, 60 ft. beam and 23 ft. mean draught, displacing 6,840 tons. She is protected by armor plate 7 in. thick, 54 in. wide forward, and 47 in. aft. She is fitted with engines of 13,000 horse power, and will have a sea speed of 19 knots. Her offensive battery consists of two 9.75 in., 80 ton guns, six 4.75 in., and ten 5.75 in. The two latter batteries are rapid-fire. There is also an extensive equipment of machine guns and torpedo apparatus. The battleship Emmanuele Filiberto is 342 ft. long, 68.6 ft. beam, and has displacement of 9,800 tons. She is fitted with a protective deck and Harveyized armor, varying from 1 1-2 in. in the gun shields to 7 in. in the turrets. Her gun equipment includes four 9.9 in., two placed in the forward turret and two in the after. Also eight 4.6 in. and eight 2.2 in. with the usual equipment of machine guns.

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## CATALOGUES.

**Users of search lights** will be much interested in Catalogue A, that has been issued by The Carlisle & Finch Co., 834 West Sixth street, Cincinnati, Ohio. The catalogue is printed in colors, and comprises eleven pages of matter, devoted exclusively to a fully illustrated description of the several sizes and types of searchlights made by this company.

**A leather covered** vest pocket memorandum book is being sent to all enquirers by the Boston Belting Co., 268 Devonshire street, Boston. It contains much information regarding hose packing, gasket, and other rubber goods, besides important points regarding steam pressures, a calendar for 1898, etc. There are also fifty or more memorandum pages.

**A cloth bound catalogue** has just been issued by the United States Metallic Packing Co., 427 North Thirteenth street, Philadelphia, Pa. It is pocket size and comprises in considerable detail, with numerous illustrations, all necessary information regarding the packing manufactured by this company and also regarding pneumatic hammers and drills. These hammers have found very extensive use for calking boilers and flues, cutting off scale, clipping boiler plates, etc.

**The steam regulating devices** and steam pumps manufactured by the Mason Regulator Co., 6 Oliver street, Boston, Mass., are thoroughly illustrated and fully described in a pocket-size price list and catalogue just from the press. The catalogue comprises 40 pages, is supplied with an excellent index and has an illustration on almost every page. A number of diagrams and sectional views are given which add to the value of the text. Copies may be had upon application to the company.

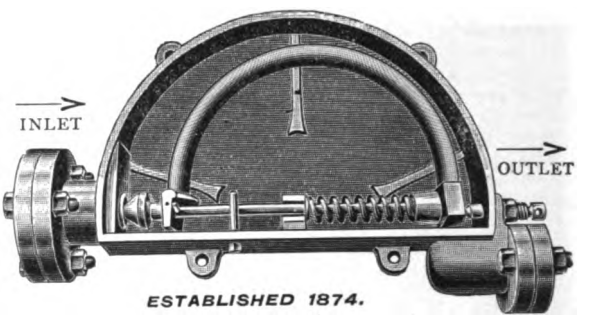
**An annex to the twenty-eighth edition** of the general catalogue issued by the Keuffel & Esser Co., 127 Fulton street, New York, has been found a necessity, and is just from the press. It is a trade price list of some over 30 pages, and should be on the table in every draughting room for ready reference in connection with the complete catalogue of this company. This pamphlet is made especially complete by a fine index. It is made the same size of the general catalogue for the convenience of filing away with it.

## BUSINESS NOTES.

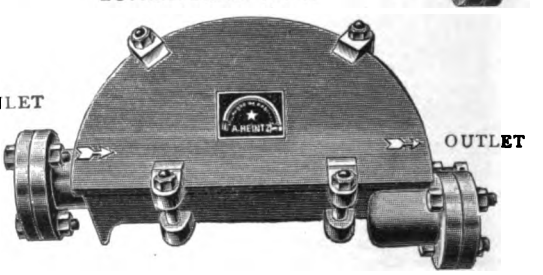
A FIRE ALARM ON SHIP BOARD.—The great danger from fire on board ship has led to the introduction of several systems of giving notice of a fire; one of the latest systems being that of the Marine Union Fire Alarm Co., 925 Chestnut street, Philadelphia. This system is in use on a number of coastwise and other vessels, and was mentioned in connection with the description of the Princess Anne published in the August issue of Marine Engineering. Several serious fires have been prevented lately on vessels using this system.

STEAM MOTORS.—A steam motor of especial value for uses in which compactness is desired is now being put on the market by James T. Halsey, Twenty-sixth and Callowhill streets, Philadelphia. The motor can be placed in any position and is adapted for running launches, electric plants, fans, or almost anything. The motor has no connecting rods, no cross heads, eccentrics, or eccentric rods, and is noiseless, but it is not by any means a rotary engine. These motors have been used for several purposes on board several transatlantic liners as well as on smaller vessels. Every engineer who has interest in such devices should have a copy of Mr. Halsey's circular.


# A Marine Trap That Never Fails.




ESTABLISHED 1874.




## The Heintz Steam Saver

*****—

has been adopted by the Marines of Belgium, France, Russia and Germany and is now attracting universal attention amongst the fraternity in the United States, where it is now being introduced.

**WHY**

it does so can be readily understood by noting the reasons. It is the SIMPLEST trap in existence. Has no levers, floats, air valves or grinding joints to wear out. Works in ANY POSITION at any pressure up to 200 pounds. "Pitch" or "list" on the ship has no influence on its results.

ELEVATES the water anywhere.

CONSUMES NO STEAM.

DOES NOT BACK UP.

NO INSIDE PRESSURE.

Easily and quickly opened.

LASTS A LIFE-TIME.

Chief Engineer of the International Steamship Co. says:—
"I like the trap better than any I have ever used."
"A. F. BREMNER."

THE CHEAPEST as well as THE BEST.

A postal card is enough to learn all about it.

**WILLIAM S. HAINES,**

Sole Manufacturer for U. S. and Canada,

136 F. South Fourth St., - Philadelphia.

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Western Steam Appliance Agency, Congress and Franklin Sts., Chicago, Ill.

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